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Dietary Restraint, Disinhibition of Eating, and Resting Metabolic Rate in Women.

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DIETARY RESTRAINT, DISINHIBITION OF EATING, AND RESTING METABOLIC RATE IN WOMEN

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Glossary of Abbreviated Terms

BIA - Bioelectrical impedance analyzer. Instrument used to determine body composition by measuring electrical conductivity.

BMI - Body mass index. Anthropometric measure calculated as weight in kilograms/height in meters^2.

BMR - Basal metabolic rate. Minimal amount of energy required to sustain the body's vital functions in the waking state.

BULIT - Bulimia Test. Psychological measure of bulimic tendencies.

BULIT-Binge - Binge subscale of the BULIT.

DEBQ-R - Dutch Eating Behavior Questionnaire-Restrained Eating Scale. Psychological measure of restrained eating.

EAT - Eating Attitudes Test. Psychological measure of anorexic attitudes and behaviors.

EAT-Diet - Dieting subscale of the EAT.

EDI - Eating Disorders Inventory. Multiscale measure of the psychological and behavioral characteristics of anorexia and bulimia.

EDI-B - Bulimia subscale of the EDI.

EDI-BD - Body Dissatisfaction subscale of the EDI.

EDI-DT - Drive for Thinness subscale of the EDI.

EDI-I - Ineffectiveness subscale of the EDI.

EDI-IA - Interoceptive Awareness subscale of the EDI.

EDI-ID - Interpersonal Distrust subscale of the EDI.

EDI-MF - Maturity Fears subscale of the EDI.

EDI-P - Perfectionism subscale of the EDI.

EQ-R - Eating Questionnaire-Revised. Psychological measure of bulimic tendencies.

FFM - Fat-free mass (lean body mass). All body tissue that is not adipose tissue.

HD - High Disinhibition. Description of subjects scoring 12 or higher on the disinhibition scale of the Three Factor Eating Questionnaire.

HR - High Restraint. Description of subjects scoring 13 or higher on the restraint scale of the Three Factor Eating Questionnaire.

HR/HD - High Restraint/High Disinhibition. Description of subjects scoring 13 or higher on the restraint scale and 12 or higher on the disinhibition scale of the Three Factor Eating Questionnaire.

HR/LD - High Restraint/Low Disinhibition. Description of subjects scoring 13 or higher on the restraint scale and 6 or lower on the disinhibition scale of the Three Factor Eating Questionnaire.

Kcal - Kilocalorie. Measure of energy equivalent to the amount of heat required to raise the temperature of one kilogram of water 1° Centigrade.

IDED - Interview for Diagnosis of Eating Disorders. Interview to assess symptoms of anorexia, bulimia, and compulsive overeating.

Kg - Kilogram. Measure of weight. One kg = 2.2 pounds.

LD - Low Disinhibition. Description of subjects scoring 6 or lower on the disinhibition scale of the Three Factor Eating Questionnaire.

LR - Low Restraint. Description of subjects scoring 6 or lower on the restraint scale of the Three Factor Eating Questionnaire.

LR/HD - Low Restraint/High Disinhibition. Description of subjects scoring 6 or lower on the restraint scale and 12 or higher on the disinhibition scale of the Three Factor Eating Questionnaire.

LR/LD - Low Restraint/Low Disinhibition. Description of subjects scoring 6 or lower on the restraint scale and 6 or lower on the disinhibition scale of the Three Factor Eating Questionnaire.

RMR - Resting metabolic rate. Energy expended at rest under normal life conditions.

RS - Restraint Scale. Psychological measure of restrained eating.

SF - Skinfold measurement. Anthropometric procedure to determine percent body fat.

TEF - Thermic effect of food. Post-prandial increase in resting energy expenditure which represents the energy used to metabolize and store ingested nutrients.

TFEQ - Three Factor Eating Questionnaire. Psychological measure of cognitive restraint, disinhibition of eating, and perceived hunger.

TFEQ-D - Disinhibition of eating scale of the TFEQ.

TFEQ-H - Perceived hunger scale of the TFEQ.

TFEQ-R - Cognitive restraint scale of the TFEQ.

UWW - Underwater weighing. Procedure used to determine percent body fat.

ABSTRACT

The effects of control (dieting) and loss of control over eating (overeating) on resting metabolic rate (RMR) were examined in a sample of 44 normal premenopausal women. A 2 (Restraint: High and Low) X 2 (Disinhibition: High and Low) design was utilized. Subjects were selected by their scores on the restraint and disinhibition scales of Three Factor Eating Questionnaire (Stunkard & Messick, 1985). The four groups were: women who alternated between dieting and overeating (HR/HD); women who dieted without overeating (HR/LD); women who did not diet or overeat (LR/LD); and women who did not diet and repeatedly overate (LR/HD). Body composition and resting metabolic rate were examined. Results indicated that subjects who controlled their eating were of normal weight, while those who did not were obese. Subjects in the LR/HD group weighed significantly more (Mean weight = 104 kg), had higher percent body fat, and more fat mass and fat-free mass than did the other groups. While weight was not significantly different across the other groups, percent fat, fat mass, and fat-free mass of HR/HD subjects was higher than that of LR/LD subjects. Percent body fat, fat mass, and fat-free mass of HR/LD subjects were similar to that of HR/HD and LR/LD subjects. Corresponding, LR/HD subjects had higher resting metabolic rates than the other groups. The resting metabolic rates of HR/HD subjects were higher than that of LR/LD subjects.

The resting metabolic rates of HR/LD subjects were similar to those of HR/HD and LR/LD subjects. When differences in body composition and age were statistically controlled, group differences in RMR were significantly attenuated. There were no differences between the groups in energy intake or expenditure. Weight history, psychological, and behavioral variables were also examined. Overall results indicated that loss of control of eating was the predominant variable affecting fatness. Implications of these findings for obesity research and the utility of the construct of dietary restraint were discussed.

Dietary Restraint, Disinhibition of Eating,

and Resting Metabolic Rate in Women

Our society is preoccupied with the relentless pursuit of thinness. We live in an age fixated on food and body size. Concerns about dieting have shifted from a leisure time activity to a national obsession. The consequences of living in such a weight-conscious culture have been most pronounced in women.

There is evidence of extensive sociocultural pressure on women to achieve a more "tubular", or androgynous, ideal body shape (Agras & Kirkley, 1986; Garner, Garfinkel, Schwartz, & Thompson, 1980; Morris, Cooper, & Cooper, 1989). The number of diet articles appearing in women's magazines has increased significantly in recent years (Agras & Kirkley, 1986; Garner et al., 1980). Paradoxically, the trend toward a thinner ideal body size has occurred in conjunction with increasing population weight norms for women (Garner et al., 1980). Several authors have speculated that this trend has contributed significantly to the national obsession with dieting and to the higher incidence of eating disorders observed among women in recent years (Agras & Kirkley, 1986; Fairburn & Garner, 1986; Garfinkel & Garner, 1982; Garner et al., 1980).

The discrepancy between women's ideal and actual body sizes suggests that many women encounter difficulty in achieving a slimmer body shape. Some women are unable to slim down despite severe dieting (Miller & Parsonage, 1975; Ravussin et al., 1988). This finding suggests that there may be biological factors which prevent desired weight loss in some women. These same factors may also be involved in the development of eating disturbances in vulnerable individuals.

Dieting and Eating Disturbances

Eating Disorders

Dieting has been associated with all forms of disordered eating. According to the revised third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R, American Psychiatric Association, 1987), the defining characteristics of anorexia nervosa are an intense fear of gaining weight, body weight that is significantly below normal weight for age and height, and a disturbance in body image in which a person perceive's herself as fat even when emaciated. In anorexia, voluntary food restriction may be severe and ongoing or may alternate with periods of uncontrolled excessive eating (Garfinkel, Moldofsky, & Garner, 1980; Garner, Garfinkel, & O'Shaughnessy, 1985; Vandereycken & Pierloot, 1983).

Bulimia nervosa is an eating disorder characterized by persistent overconcern with body size, recurrent episodes of binge eating, feelings of loss of control over eating, and recurrent attempts to prevent weight gain. Methods used to avoid weight gain can include strict dieting or fasting, self-induced vomiting, use of laxatives or diuretics, and vigorous physical exercise (DSM-III-R, American Psychiatric Association, 1987).

Clinical reports indicate that most bulimic patients have a history of dieting, and that periods of voluntary restrictive dieting frequently precede the onset of bulimic symptoms (Abraham & Beumont, 1982; Johnson, Stuckey, Lewis, & Schwartz, 1982; Pyle, Mitchell, &

Eckert, 1981). Alternating periods of binging and fasting are commonly reported (Pyle et al., 1981; Pyle, Mitchell, Eckert, Halvorson, Neuman, & Goff, 1983). Furthermore, Mitchell, Hatsukami, Eckert, and Pyle (1985) found that consumption of normal meals was fairly infrequent in a group of 275 bulimic patients. Only 21% of the sample reported that they ate more than two normal meals per day; 19% ate only one normal meal a day; 39% ate a normal meal once or several times a week; and 21% ate normal meals once a week or less. This pattern of erratic or "chaotic" eating, i.e., cyclical periods of caloric restriction followed binging, may prove to be of diagnostic and prognostic significance in the development and treatment of eating disorders.

Although not considered a formal eating disorder, obesity and its associated overeating, may also be related to a chaotic eating style involving periods of severe caloric restriction and overconsumption. While frequent dieting is taken for granted in overweight individuals, its causal connection with obesity has not received much attention. Traditionally, the relationship has been considered a repetitive cycle of overly strict dieting followed by compensatory overeating. Restrictive dieting has been hypothesized to cause biological deprivation, which produces hunger, which in turn leads to obsessions about eating, feelings of self-denial and deprivation, permission to indulge, and finally ends in overindulgence followed by renewed attempts at restrictive dieting (Loro & Orleans, 1981; Polivy & Herman, 1985; Smith & Fremouw, 1987).

The similarity between anorexia, bulimia, and obesity in terms of dieting is most notable. The spectrum concept of disease refers to a closely-related set of disorders with one or more fundamental unifying features. Recent literature suggests that disorders of eating may occur on a spectrum (Andersen, 1983; Garner, Garfinkel, & O'Shaughnessy, 1983; Garner, Olmsted, & Garfinkel, 1983; Mickalide & Andersen, 1985; Patton, 1988; Schlundt & Johnson, 1990). Fear of weight gain has been proposed as the core of all forms of eating disorders (Fairburn & Garner, 1986; Schlundt & Johnson, 1990; Williamson, 1990). Therefore, dieting is believed to play a significant role in the etiology of weight control problems and eating disturbances.

Normal Eating

The prevalence of dieting among young women is well-documented and has even been described by some as "normal eating" (Polivy & Herman, 1987). In a one survey of over 1,200 female high school students, Johnson, Lewis, Love, Stuckey, and Lewis (1983) found that 36% percent of the respondents were currently dieting; 69% engaged in dieting at some point before the survey; 52% began dieting before age 14; 44% reported going on a diet between one and five times during the past year; and 14% considered themselves to be chronic dieters. In another study, up to 44% of female students between the ages of 16 and 18 reported a current or previous history of dieting (Nylander, 1971). There is also data to suggest that girls as young as 12 years of age are extremely concerned about their weight and attempt to diet to achieve a thinner ideal body size (Wardle & Beales, 1986). We can conclude from these findings that the cultural preoccupation with dieting is likely to begin at a very young age and to become well-entrenched in young women by adolescence and young adulthood, the time at which eating disorders tend to develop.

Pyle and his colleagues (1983) examined the relationship between dieting and the incidence of disordered eating among college students. Findings indicated that 4% of college freshmen met the DSM-III (American Psychiatric Association, 1980) diagnostic criteria for bulimia. Seventy-six percent of them reported engaging in 24-hour fasts and 27% on at least a weekly basis. Further findings indicated that 30% of the students who did not meet the criteria for bulimia reported engaging in fasting at some time prior to the survey. The excessive preoccupation with weight and body size among young women in our culture, and the high incidence of pathological eating reported among college students (Halmi, Falk, & Schwartz, 1981; Hawkins & Clement, 1980; Johnson et al., 1983; Pyle et al., 1983), suggest that dieting is very common among young women and may be related to the development of eating disorders.

The prevalence of dieting and binge eating among women has led to the identification of a subgroup of normal women who are arousing clinical interest. Although these women are of normal weight, they exhibit an extreme preoccupation with weight, excessive fear of weight gain, as well as a relentless pursuit of thinness. While minor lapses of behavioral control, i.e, binges, may or may not occur, these women manage to maintain normal weights by frequent restrictive dieting. These women have been labelled "chronic dieters", "weight-preoccupied", "diet-conscious", and "restrained" (Bunnell, Shenker, Nussbaum, Jacobson, & Cooper, 1990; Button & Whitehouse, 1981; Dykens & Gerrard, 1986; Garner, Olmsted, & Garfinkel, 1983; Garner, Olmsted, Polivy, & Garfinkel, 1984; Polivy & Herman, 1987; Williams, Schaefer, Shisslak, Gronwaldt, & Comerci, 1986).

Given the extent of weight-preoccupation and dieting in our society, it is probable that subclinical forms of eating disorders are quite common and perhaps even considered "normal" eating (Polivy & Herman, 1987). Subclassification of restrained women in terms of control versus lack of control over eating may have clinical importance. While one could speculate that the more extreme and chaotic the pattern of dieting and overeating are, the higher the risk for developing an eating disorder, this hypothesis awaits empirical verification. If this speculation was supported, the importance of defining the role of chronic restrictive dieting in the development of eating disorders would become paramount. Such a finding would also have implications for the treatment of "normal" as well as disordered eating.

There appears to be substantial data to indicate that dieting and eating disturbances are closely related, possibly such that dieting is a necessary antecedent to binge eating. Because some women have difficulty losing weight despite severe dieting, it is possible that biological factors related to dieting may impede weight loss. As will be discussed in subsequent sections of this paper, there is extensive evidence to suggest that dietary practices can have pronounced effects on the body's metabolic processes. Therefore, it is possible that certain dietary patterns may affect the body's metabolism and serve as precursors to more serious eating disturbances in some individuals.

Metabolism and Energy Expenditure

Metabolism is defined as the sum total of physiological and chemical processes involved in the maintenance of life. All metabolic processes in the human body ultimately depend on biological oxidation and result in energy expenditure and heat production. A basic law of thermodynamics, the law of conservation of energy, states that the expenditure of a fixed amount of energy will always result in the production of the same amount of heat. Therefore, energy exchange of the body can be expressed in terms of a unit of heat, i.e., the calorie. A calorie is defined as the amount of heat required to raise the temperature of one kilogram (kg) of water one degree Centigrade (from 15° to 16° C). Because the calorie is a very small quantity, the term kilocalorie (kcal) is more frequently used. A kcal equals 1000 calories. Because of the law of conservation of energy, the amount of energy expended by the body can be easily measured. This expenditure is expressed as metabolic rate. Metabolic rate is defined as the rate at which the body produces heat, typically expressed as kcal/unit of time. This heat production is the result of burning calories while converting nutrients into energy. The body's energy production can be separated in several distinct components.

Components of Metabolic Rate

Energy balance in the body is a function of metabolic rate. Energy balance refers to the relationship between energy input and energy output or expenditure. When energy input equals output, stable body weight is maintained. In positive energy balance, intake exceeds output and weight is gained. In negative energy balance, output exceeds input and weight is lost. While energy input is accomplished only through food consumption, the body expends energy in one of three major ways.

First, there is a minimal amount of energy required to sustain the body's vital functions in the waking state. This energy expenditure is referred to as basal metabolic rate. The vital functions supported by basal metabolism include activities of many organs such as the lungs, kidneys, liver, heart, and brain, the secretory activities of the glands, the peristaltic movements of the gastrointestinal tract, oxidation occurring in resting tissue, and the maintenance of muscle tone and body temperature. The brain and nervous tissue in adults account for approximately one fifth of the energy expended in basal metabolism, while the liver, kidneys, lungs, and heart account for an additional three fifths. Basal metabolic rate accounts for 70-80% of the body's total energy expenditure (McArdle, Katch, & Katch, 1981; Robinson, Lawler, Chenoweth, & Garwick, 1986).

The measurement of basal metabolic rate (BMR) should be differentiated from the measurement of resting metabolic rate (RMR). Measurement of BMR requires that the subject remain in bed following a night's sleep and refrain from any physical activity. Because of the restrictive conditions necessary to accurately measure BMR, RMR is more frequently assessed (Perkins, McKenzie, & Stoney, 1987). RMR applies to energy expenditure under normal life conditions while at rest and is typically 10-15% higher than basal metabolic rate (Stegemann, 1981). However, the two terms are often used interchangeably in the literature. The average adult RMR is approximately 1 kcal/kg of body weight/hr (McArdle et. al., 1981; Robinson et al., 1986).

A number of factors influence RMR. Fixed individual characteristics related to RMR include age, sex, and body weight. Resting metabolic rate is highest during childhood and declines approximately 2% per decade after age 21. Women's RMR is about 6-10% lower than men's. Body size and composition are very important factors in RMR. As body weight increases, body surface area, lean body mass, active metabolic tissue, and thus, RMR increase. Therefore, it is common practice to express RMR in terms of either body surface area, "fat-free" mass, or lean body mass (McArdle et. al., 1981; Perkins et al., 1987; Robinson et al., 1986).

Transient influences on RMR include body temperature and health status, as well as recent intake of caffeine, nicotine, and certain medications. An elevation of body temperature above 98.6° F increases RMR by 7% for each degree. Hyperthyroidism can increase RMR by as much as 75-100%, while hypothyroidism can reduce RMR by 30-40%. Respiratory disease, anxiety, stress, and pituitary dysfunction can increase RMR. Caffeine and nicotine ingestion elevate RMR, while antidepressant medication lowers RMR (McArdle et. al., 1981; Perkins et al., 1987; Robinson et al., 1986). Two additional variables must be considered when examining RMR in women. During the last trimester of pregnancy, RMR can increase by 15-25%. Changes in RMR of up to 15%

have also been reported across phases of the menstrual cycle. RMR tends to be higher in the pre-menstrual than in the post-menstrual phase of the cycle (Solomon, Kurzer, & Calloway, 1982; Webb, 1986). Recent evidence suggests that these cyclical changes may be related to changes in the pattern of energy intake and food selection which occur across the menstrual cycle (Tarasuk & Beaton, 1991).

The second and third major components of total energy expenditure consist of energy used to metabolize ingested food and energy expended during physical exertion. The ingestion of food causes RMR to increase up to a peak one to two hours postprandially. This increase reflects the energy expended to digest and absorb the food. The increase in metabolic rate may persist for up to six to eight hours before returning to premeal levels (D'Alessio et al., 1988; Segal, Edano, & Tomas, 1990). The post-prandial increase in energy expenditure has been alternately referred to as the thermic effect of food (TEF), specific dynamic action of food (SDA), and dietary-induced thermogenesis (DIT). The size of the effect is dependent upon the composition of the meal, i.e., percentages of fat, carbohydrates, and protein, as well as on the size of the meal relative to the individual's body weight. The extent of the increase in energy expenditure after eating can vary widely, but is typically between 8-15% of the calories ingested and can represent up to a 30% increase above RMR (D'Alessio et al., 1988; Horton, 1983; Jequier & Schutz, 1985; Segal, Edano, Blando, & Pi-Sunyer, 1990; Segal, Edano, & Tomas, 1990). A reduction in the magnitude of this effect can account for a substantial decrease in total energy expenditure over time and, with everything else being equal, result in significant weight gain over time.

Energy expended through physical exertion also has a pronounced effect on RMR. The size of the effect is dependent upon the type and duration of activity. Sedentary activity, such as reading, writing, or watching television typically involves expenditure of from 80 to 100 kilocalories per hour. More strenuous exercise, such as swimming, running, or bicycling can consume more than 350 kilocalories per hour (McArdle et al., 1981; Robinson et al., 1986). Therefore, increasing energy expenditure through exercise can significantly affect energy balance and contribute to weight loss in the absence of additional intake.

Several procedures are available for measurement of metabolic rate. Some methods allow for independent assessment of the contributions of resting metabolic rate, the thermic effect of food, and physical activity to total energy expenditure. Measurement of metabolic rate can be conducted directly, by measuring the amount of heat produced or indirectly, by measuring the amount of oxygen consumed.

Assessment of Metabolic Rate

Direct measurement, i.e., direct calorimetry, refers to the measurement of heat produced by the body. This procedure requires a specially constructed calorimetry chamber which is climate-controlled and sealed to prevent uncontrolled air flow. Humidified air is continually supplied. Expired carbon dioxide is removed by chemical absorbents. A normal oxygen supply is maintained by adding oxygen to the air before it reenters the chamber. The heat produced by an individual is transmitted to water flowing through coils in the chamber. Measurement of the water temperature over an extended period of time, typically at least 24 hours, is used to calculate an individual's total energy expenditure. Calorimetry chambers are expensive to construct and require careful attention to detail during measurement. These chambers are used only at a few research centers (McArdle et al., 1981; Perkins et al., 1987; Robinson et al., 1986).

Because all energy metabolism in the body ultimately depends on the utilization of oxygen, measurement of the body's oxygen consumption and carbon dioxide production provides an indirect method to assess energy expenditure. Some calorimetry or respiration chambers measure metabolism indirectly by measuring oxygen consumption. Indirect calorimetry can also be accomplished by the use of open or closed spirometry systems. A closed system requires that an individual breathe and rebreathe a predetermined concentration of oxygen from a prefilled container. Carbon dioxide is removed by chemical absorbents. Oxygen consumption is measured. This technique can be cumbersome when energy expenditure from physical activity is being measured. Closed systems are also less accurate than open systems and are rarely used for research purposes. In an open spirometry system, an individual breathes in ambient air which is generally 20.9% oxygen and 0.03% carbon dioxide at sea level. Differences in the concentrations of oxygen and carbon dioxide in ambient and expired air, along with the volume of expired air, determine the amount of oxygen consumed, and thus, energy expended.

Open circuit indirect calorimetry is accurate to within 1% of direct calorimetry (McArdle et al., 1981; Perkins et al., 1987; Robinson et al., 1986).

Because even open circuit systems can greatly restrict spontaneous activity, a third nonintrusive method of indirect calorimetry has recently received increased attention. The doubly labeled water method is based on the relationship between water metabolism and respiration, and is a function of the turnover rates of oxygen and body water. In this procedure, a loading dose of the stable isotopes ^2H and ^{18}O is administered orally. The decline in the concentration of isotopic O in body water represents a measure of H_2O and CO_2 output, while the decrease in isotopic H in body water relates only to H_2O output. The rate of CO_2 production can be determined by the difference in the elimination rates of the two isotopes. Energy expenditure is then computed on the basis of oxygen consumption and carbon dioxide production in a manner similar to that used in traditional indirect calorimetry (Bandini, Schoeller, Cyr, & Dietz, 1990; Tuschl Platte, Laessle, Stichler, & Pirke, 1990). This method is expensive and requires highly specialized instrumentation. To date, the technique has enjoyed only limited use in the investigation of metabolic rate.

Open circuit indirect calorimetry has been the most frequently used method for assessing energy expenditure. Different systems utilize ventilated hoods, face masks, or nose clips and mouthpieces to measure expired gases. Similar results have been obtained using the three methods (Segal, 1987). Recent evidence suggests that subjects must acclimate to the equipment before measurements of metabolic rate can be assumed to be accurate (Soares, Sheela, Kurpad, Kulkarmi, & Shetty, 1989). Because anxiety and increased respiration elevate metabolic rate, failure to familiarize subjects with the equipment can introduce random error and produce spurious results.

The various effects of dieting on metabolic rate have been studied extensively. While there has been some research on the effect of different dietary practices on metabolic rate, specific investigation of the metabolic effect of alternating cycles of dieting and overeating has received only limited attention. Current data on the phenomenon of weight cycling, i.e., cycles of weight loss followed by regain, are relevant to this topic and may help to elucidate the relationship between these dietary practices and metabolism.

Effect of Dieting and Weight Cycling on Metabolic Rate

According to the basic laws of thermodynamics, stable body weight, i.e., energy balance, is maintained when energy input equals energy output. To decrease body weight, energy output must exceed input. Alterations on either side of the equation can lead to weight loss (negative energy balance). Caloric intake can be reduced below daily energy requirements or additional physical activity can increase caloric output above daily energy requirements. Weight loss, therefore, intrinsically consists of a change in energy balance involving reduced energy intake and/or increased energy expenditure. As demonstrated previously, reduction in caloric intake appears to be the most prevalent method of weight control, particularly among women in our society. Thus some degree of undernutrition, which is dependent upon the extent of caloric restriction, is required to lose weight by dieting. In the following section, evidence will be presented that chronic dieting can lead to a metabolic adaptation to reduced caloric intake which can impede further weight loss.

Dieting/Fasting

Research examining the biological and psychological effects of restrictive dieting dates back forty years to the classic semi-starvation studies conducted by Keyes and his colleagues at the University of Minnesota (Keyes, Brozek, Henschel, Mickelsen, & Taylor, 1950). A prominent finding of these studies was that severe restriction of caloric intake resulted in decreased body weight and increased energy efficiency as manifested by a decline in basal metabolic rate. Keyes and his colleagues estimated that approximately 65% of the decline in basal metabolic rate following semi-starvation resulted from loss of lean body tissue, while 35% of the decline resulted from increased energy efficiency, i.e., decreased expenditure in the metabolic processes of the remaining tissue. In this state, all essential body functions are slowed, and body temperature lowered, in an effort to reduce caloric expenditure.

Subsequent research has replicated the finding of Keyes and his colleagues that decreases in basal metabolic rate can significantly exceed that predicted based solely on the loss of metabolically active tissue (Apfelbaum, Bostarron, & Locatis, 1971; de Groot, van Es, van Raaij, Vogt, & Hautvast, 1989; den Besten, Vansant, Weststrate, & Deurenberg, 1988; Elliot, Goldberg, Kuehl, & Bennett, 1989; Heshka, Yang, Wang, Burt, & Pi-Sunyer, 1990; Weigle, Sande, Iverius, Monsen, &

Brunzell, 1988). Evidence also suggests that a personal and family history of obesity may be associated with a lower resting metabolic rate (Newman, Halmi, & Marchi, 1987; Ravussin et al., 1988; Shah, Miller, & Geissler, 1988, Stordy, Marks, Kalucy, & Crisp, 1977; Walker, Roberts, Halmi, & Goldberg, 1979).

While dieting appears to be the most prevalent method of weight control in our culture, recent data suggest that exercise can counteract some of the energy conserving metabolic adaptation to dieting. Aerobic exercise has been shown to increase resting metabolic rate in dieters (Davis, Sadri, Sargent, & Ward, 1989; Donahoe, Lin, Kirschenbaum, & Keesey, 1984; Hill et al., 1989; Wadden, Foster, Letizia, & Mullen, 1990). Exercise, when coupled with food restriction, favors loss of body fat and preserves fat-free mass (Hill, Sparling, Shields, & Heller, 1987). Similarly, aerobic fitness is positively correlated with resting metabolic rate (Poehlman, Melby, Badylak, & Calles, 1989). These findings suggest that, for individuals who are not physically fit, increased aerobic activity is an important component of successful weight loss. While exercise may enhance weight loss, repeated cycles of weight loss followed by weight gain may produce the opposite effect.

Weight Cycling

It is not uncommon for individuals to lose weight by dieting only to regain it. The phenomenon of weight loss followed by regain, particularly if it occurs in repeated cycles, has been referred to as weight cycling or the "yo-yo syndrome" (Brownell & Stein, 1989). It is possible that physiological adaptations to dieting may make future weight loss and even weight maintenance difficult. Recent evidence suggests that the decreased metabolic rate associated with dieting can persist beyond a period of dieting (Elliot et al., 1989; Heshka et al., 1990). It has further been suggested that the decrease in RMR may represent a metabolic adaptation to lowered food intake which could create a predisposition to obesity in some individuals (Dulloo & Girardier, 1990; Miller & Parsonage, 1975).

Several investigators have examined the effect of repeated cycles of weight loss on metabolism. Current research findings tend to support the experience of many chronic dieters who cycle between weight loss and regain. Brownell, Greenwood, Stellar, and Shrager (1986) found that lab animals exposed to repeated periods of caloric restriction and refeeding regained weight three times more rapidly after the second dieting cycle than after the first. Similarly, animals took twice as long to lose the same amount of weight the second time as they did the first. Cycled animals demonstrated a four-fold increase in food efficiency compared to obese animals of the same weight who had not cycled. These findings suggest that more efficient energy utilization is associated with weight loss followed by regain. Thus, weight cycling may retard weight loss and promote weight gain.

The few human studies which have examined the effects of weight cycling on RMR have yielded inconclusive results. Some studies support the finding of increased energy efficiency with weight cycling in overweight subjects (Blackburn et al., 1987; Blackburn et al., 1989) and adolescent male wrestlers (Steen, Oppliger, & Brownell, 1988). However, recent human studies of collegiate male wrestlers (Melby, Schmidt, & Corrigan, 1990), obese subjects (van Dale & Saris, 1989), as well as the results of some animal research (Graham, Chang, Lin, Yakubu, & Hill, 1990; Wheeler, Martin, Lin, Yakubu, & Hill, 1990), failed to demonstrate the effect. There is also some data to suggest that the lowered metabolic rate seen with weight cycling may be a consequence of lowered intake of high fat food (Graham et al., 1990).

The foregoing results have great implications for the study of RMR in dieting individuals. Those who work in the field of weight control are all too familiar with the problem of maintaining weight loss. Weight loss followed by regain appears to be the norm rather than the exception. Furthermore, a long history of dieting is generally considered a indicator of poor prognosis in achieving long-term weight loss (Brownell & Stein, 1989).

Restrictive dieting has been shown to be a prominent factor associated with disordered eating behavior. Metabolic adaptations to dieting may play an important role in the maintenance and exacerbation of eating disturbances. Metabolic alterations from weight cycling may also contribute to disturbed eating practices. The effect of dieting on RMR has been studied in individuals with different forms of disordered eating behavior.

Resting Metabolic Rate in Eating Disorders

Obesity

The effect of caloric restriction (dieting) on RMR has been studied extensively in obese subjects. While there is evidence that

RMR can decrease by 10-22% depending on the degree of caloric restriction (Apfelbaum et al., 1971; de Groot et al., 1989; den Besten et al., 1988; Elliot et al., 1989; Weigle et al., 1988), during weight maintenance, RMR and 24-hour energy expenditure in obese subjects are similar to those of normal-weight subjects after controlling for differences in amount of lean body tissue or fat-free body mass (FFM) (Foster et al., 1988; Miller & Parsonage, 1975; Prentice et al., 1986; Ravussin, Burnand, Schutz, & Jequier, 1982; Ravussin, Lilloja, Anderson, Christin, & Bogardus, 1986; Segal & Gutin, 1983). Lean body tissue is metabolically more active than adipose tissue and appears to be the best determinant of 24-hour energy expenditure and RMR (Foster, et al., 1988; Heshka et al., 1990; Ravussin et al., 1986).

Dietary restriction can lower RMR an amount nearly double that expected based on weight loss (Donahoe et al., 1984). Resting metabolic rate was found to be about 15% lower in post-obese subjects than in age-, weight-, and height-matched lean controls (Geissler, Miller, & Shah, 1987; Shah et al., 1988). However, in these studies, caloric intake in post-obese subjects was 70% of that of matched controls. Other studies have demonstrated that lowered RMR can persist for many months following massive weight loss despite increased caloric consumption and body weight stabilization (Elliot et al., 1989; Heshka et al., 1990; Weigle et al., 1988). These findings strongly argue for increased energy efficiency with weight loss. Extended suppression of RMR may also explain the increasing difficulty in losing weight as weight loss progresses, as well as the phenomenon of weight cycling. Attempts to alternate periods of low energy intake with less restrictive consumption have failed to prevent this decline in energy expenditure (de Groot et al, 1989; Hill et al., 1989). However, as stated earlier, there is evidence to suggest that the decline in RMR can be counteracted to some degree when weight loss is achieved by a combination of diet and exercise rather than by caloric restriction alone (Davis et al., 1989; Donahoe et al., 1984; Hill et al., 1989; Wadden et al., 1990).

Anorexia and bulimia

In contrast to the extensive literature on resting metabolic rate in obesity, investigation of RMR in anorexia and bulimia has received only limited attention. Current findings indicate that prolonged starvation in anorexia results in a reduced RMR even after correcting for small body size.

Stordy, Marks, Kalucy, and Crisp (1979) examined RMR in a group of 15 hospitalized anorexic females and six age-, and height-matched normal-weight controls. RMR was 24% lower in anorexic subjects. Thirty-seven percent of this reduction was the result of low body weight while 63% of the reduction was the result of the economy of energy utilization. During refeeding, previously obese anorexic subjects gained weight more rapidly, on the same food intake, than did those subjects who had never been obese. As refeeding progressed, RMR increased to a lesser degree in previously obese anorexics than in anorexics who had never been obese. The pattern of data suggested that previously obese anorexics may be more energy efficient than those who do not have a history of obesity. Walker, Roberts, Halmi, and Goldberg (1979) also found evidence to suggest enhanced energy efficiency in anorexics who had previously been obese. Previously obese anorexic subjects required fewer calories for weight gain than did anorexics with no such history. Because anorexics are highly restrained eaters, it is possible that anorexics with a history of obesity tend to cycle between periods of excessive control and loss of control over eating, i. e., chaotic eating. Therefore, one could speculate that previously obese anorexics may be biologically prone to more economical energy utilization because of a lower RMR.

Several researchers have addressed the issue of possible enhanced energy efficiency in bulimic subjects. Kaye, Gwirtsman, Obarzanek, George, Jimerson, and Ebert (1986) showed that restricting anorexics required 30-50% more calories for weight maintenance than did bulimic anorexics. The authors suggested that chronic binging and purging may enhance the efficiency of energy utilization and constitute a possible predisposition to obesity. Newman, Halmi, and Marchi (1987) found a significant negative correlation between history of obesity, as defined by highest previous body mass index and calories required to maintain weight, in groups of bulimic and anorexic subjects. Gwirtsman, Kaye, Obarzanek, George, Jimerson, and Ebert (1989) showed that bulimic patients consumed fewer calories per kilogram of body weight to maintain weight than did normal-weight controls with similar activity levels and body composition. In this study, however, clinical variables such as history of anorexia or obesity did not account for the differences in energy efficiency between the groups.

Four recent studies have directly examined RMR in bulimic subjects. Bennett, Williamson, and Powers (1989) measured RMR in 26 bulimic females and 16 age-, height-, and weight-matched controls. Findings indicated that severe bulimia (average of 7.5 purges/week) was associated with lower RMR (0.86 kcal/hr/kg). However, RMR in less severe bulimia (average of 3.9 purges/week) was identical to normal-weight controls (0.99 kcal/hr/kg). Devlin, Walsh, Kral, Heymsfield, Pi-Sunyer, and Dantzic (1990) examined RMR in 22 normal-weight bulimics and 19 age- and weight-matched controls. Mean RMR of bulimics was significantly lower than that of controls (1229 versus 1342 kcal/24 hr). However, findings indicated a great deal of variability in RMR in the bulimic group, with several bulimics lying above as well as below the control range. Furthermore, the small but significant difference between the groups in RMR when expressed in terms of lean body tissue (28 vs 32 kcal/24h/kg) was only evident when RMR was reported in terms of FFM as measured by bioelectrical impedance. Differences between the groups were not significant when FFM was measured by anthropometry or hydrostatic weighing. Findings also indicated that maximum previous weight tended to be higher, and minimum previous adult weight significantly lower, in bulimic subjects. Bulimic's current percent of highest weight was significantly lower, and extent of weight fluctuation significantly higher, than controls'. Results presented by Devlin and his colleagues are consistent with the speculation that some bulimics may weight cycle. In contrast to these findings, one recent study failed to find differences in RMR between 24 hospitalized bulimic patients who purged more than three times per week and control subjects (Leitenberg, 1990).

One shortcoming of the preceding studies was the absence of information on subject's caloric intake. However, in a recent case report, Sedlet & Ireton-Jones (1989) found that modification of the abnormal eating pattern of a 105-pound bulimic subject resulted in normalization of her energy expenditure. This subject's intake ranged from 600 kcal on semi-fasting days to 3,800 kcal on binge days. Pretreatment RMR was 829 kcal/24 hours. RMR seven months after a nutritional intervention treatment was 1,202 kcal/24 hours, a value similar to that predicted based on the subject's height and weight.

While current data tend to suggest increased energy efficiency in bulimics, as manifested by a decreased resting metabolic rate compared to normal-weight controls, this effect has been difficult to demonstrate in less severe bulimic subjects. Significant differences among bulimic subjects in terms of binging and purging behavior, degree of restraint between binges, and weight history may tend to obscure the effect. Nevertheless, there is some evidence to suggest that the abnormal eating pattern of bulimia may result in a lowered RMR which can be normalized following regulation of abnormal dietary practices.

Methodological Considerations

In studies examining resting metabolic rate in anorexic, bulimic, or obese dieting subjects, comparison controls are generically defined as normal-weight or lean. Characteristics of controls subjects other than anthropomorphic data and absence of an eating disorder has typically not been presented. History of chronic dieting in experimental subjects is implied but often not stated, as is the absence of this history in controls. Given the prevalence of restrictive dieting and eating disturbances in our society, coupled with the identification of a group of "normal" women who exhibit a subclinical form of eating disorder, examination of metabolic differences between subgroups of normal women who differ in dieting and eating practices appears warranted.

Findings on weight cycling may be applicable to women who fluctuate between periods of restrictive dieting and excessive consumption. The literature indicates that bulimics report frequent weight fluctuations (Abraham & Beumont, 1982; Pyle et al., 1981), further suggesting that they tend to weight cycle. Similarly, even among normal eaters, women who diet frequently tend to be heavier and to report higher maximal body weights than do women who do not have an extensive history of dieting (Laessle, Tuschl, Kotthaus, & Pirke, 1989b; Tuschl et al., 1990). These findings suggest that restrained eaters may also weight cycle. Thus it is possible that women who chronically diet may manifest increased energy efficiency similar to that observed in obese weight cyclers. These women would, therefore, require fewer calories than predicted based on their body size to maintain their weight. Since lowered metabolic rate can persist for some time after restrictive dieting, once an individual begins to increase caloric intake, weight gain could be rapid.

Dietary restraint has been proposed as a conceptual framework for interpreting a pattern of disordered eating consisting of cyclical periods of restrictive dieting followed by periods of excessive consumption (Polivy & Herman, 1985; Polivy & Herman, 1987; Ruderman, 1986). This eating pattern has been described among both normal and disordered eaters. As will be discussed in the following section, the construct of dietary restraint could have great utility in the study of resting metabolic rate and eating behavior.

Dietary Restraint Theory

Traditional Perspectives

Restraint theory has it's roots in Nisbett's (1972) "set-point" theory of normal and obese eating styles. Restraint theory hypothesizes that individuals who are below their biologically determined "set-point" or ideal body weight, and chronically diet in response to social and medical pressures, will be chronically hungry and, therefore, struggle between the desire to eat and efforts to resist the temptation. Failure to resist leads to overeating. Thus, being diet-conscious, or practicing restrained eating, is postulated to cause subsequent overeating (Polivy & Herman, 1985). Clinical evidence that dieting precedes the onset of binge eating (Abraham & Beumont, 1982; Johnson et al., 1982; Pyle et al., 1981) supports the sequence of events proposed by restraint theory.

The construct of restraint has demonstrated its utility in laboratory studies by its ability to successfully predict eating behavior. The majority of the laboratory work on dietary restraint has focused on the "disinhibition" or suppression of restrained eating in normal dieters. While dietary restraint represents a conscious restriction of eating for the purpose of weight control, disinhibition represents loss of control over eating. In the laboratory, typically under the guise of a taste test, subjects scoring high on a measure of restraint have repeatedly demonstrated the phenomenon of "counter-regulation" or overeating (Polivy & Herman, 1987). This dysfunctional eating behavior has been found in restrained eaters who exceed, or believe that they exceed, their permissible limits of restricted food consumption. Restrained eaters have been found to eat more in a free-eating situation than do unrestrained eaters following manipulations to disinhibit eating. Disinhibition of eating can result from the consumption of real or perceived large, forced, high-calorie preloads, the anticipation of overeating, deficient self-monitoring, social influences, situational demands, alcohol, and negative emotional states, such as anxiety and depression (see Polivy & Herman, 1985; Ruderman, 1986 for reviews). Traditionally, counter-regulation in the laboratory has been regarded as an experimental analogue of an eating binge (Polivy & Herman, 1985; Wardle, 1987; Wardle & Beinart, 1981).

Findings of studies on restraint consistently indicate that disinhibition of eating is cognitively mediated (Polivy & Herman, 1985; Ruderman, 1986). Disinhibition and subsequent overeating appear to involve a cognitive mechanism whereby a binge represents a kind of capitulation in light of the belief that "restraint rules" have been broken and a diet has been "blown" (Polivy & Herman, 1985). This process is analogous to the "abstinence violation effect" which Marlatt and Gordon (1980) have described in addictive disorders.

Despite extensive replication of the phenomenon of counter-regulation in restrained eaters in the laboratory, there is typically considerable variance in food consumption between subjects.

Some restrained subjects even fail to counter-regulate (Duchmann, Williamson, & Stricker, 1989; Herman, Polivy, & Esses, 1987; Lowe & Kliefield, 1988; Polivy & Herman, 1985; Wardle & Beales, 1987, 1988). Inconsistent findings suggest that there is a great degree of heterogeneity among restrained eaters. These discrepancies have also provoked the speculation that dietary restraint may be a more complex phenomenon that originally proposed. This issue is demonstrated by the scales designed to measure the construct of restrained eating.

Measurement of Dietary Restraint

Restraint was initially operationally defined by a questionnaire called the Restraint Scale (Herman & Mack, 1975). The original Restraint Scale (RS) consisted of five items relating to diet-consciousness or the conscious intent to restrict food intake. The scale has been revised and expanded over the years. The most recent version consists of ten items related to dieting, concerns about weight and eating, and weight variation (Heatherton, Herman, Polivy, King, & McGree, 1988). To date, the RS has been the most widely used psychometric measure of restrained eating.

In recent years, however, the validity of the RS has been challenged on both conceptual and psychometric grounds (Ruderman, 1986). While the phenomenon of dietary restraint has been construed as a unitary construct, the RS has repeatedly been shown to have two underlying factors: concern for dieting (CD) and weight fluctuation (WF). Current evidence also suggests that the two factors may have differential predictive validity in normal-weight and obese subjects (Heatherton et al., 1988; Ruderman, 1986). While it has been suggested that obese subjects' high restraint scores reflect the greater extent of their weight fluctuation rather than their concern with dieting (Ruderman, 1986), recent evidence tends to refute this speculation (Heatherton, Polivy, & Herman, 1991). The RS has been further criticized because it fails to discriminate between actual food restriction and loss of control over eating, i.e., restraint and disinhibition of eating (Stunkard & Messick, 1985). Heatherton and his colleagues (1988) suggested that the label "restraint scale" may be a misnomer because the RS involves measurement of a "multifaceted syndrome involving both a propensity to restrict food intake as well as a tendency to splurge" (p. 26).

In an attempt to eliminate the shortcomings of the RS, two alternative measures of dietary restraint have recently been constructed. The Three Factor Eating Questionnaire (TFEQ, Stunkard & Messick, 1985) provides individual scale scores for cognitive restraint, disinhibition of eating, and perceived hunger. The restraint factor (TFEQ-R) is composed of 21 items incorporating items from the CD factor of the RS and additional items relating to conscious restriction of food intake to control weight. The Restrained Eating Scale (DEBQ-R) of the Dutch Eating Behavior Questionnaire (DEBQ, Van Strien, Frijters, Bergers, & Defares, 1986) is composed of 10 items describing the intention to restrict intake for purposes of weight control.

Heatherton et al. (1988) proposed that these new scales are not without their own limitations. These authors contend that by attempting to isolate only successful caloric restriction, the TFEQ-R and DEBQ-R do not measure the same behavioral tendencies as the RS does. While the RS was designed to identify dieters in general, the TFEQ-R and DEBQ-R were designed to identify only successful dieters. Thus, Heatherton and his colleagues (1988) suggest that the three scales may be measuring different constructs.

Laessle, Tuschl, Kotthaus, and Pirke (1989a) examined the relationship of the three scales to self-reported daily caloric intake, as well as to several measures of disordered eating and figure-consciousness. Results indicated that the construct of restraint was composed of three separate factors which accounted for 72% of the variance. Therefore, rather than measuring different constructs, the three scales likely measure different components of the restraint construct. According to the Laessle et al. analysis, the first component of restraint represented motivational variables, including concerns about shape and weight, as well as a drive for thinness. This factor was common to all three scales. The second component, which represented unsuccessful dieting, and involved overeating or disinhibited eating and weight fluctuation, was best measured by the RS, particularly the weight fluctuation (WF) subscale. The third component of restraint represented successful dieting or the actual restriction of food intake. The TFEQ-R and DEBQ-R were the best measures of this component. While significant correlations were found between the scales, the correlation between the TFEQ-R and DEBQ-R was the strongest ($\underline{r} = .66$, $\underline{p} < .0001$). This finding supports the speculation of Heatherton and his colleagues (1988) that the TFEQ-R and DEBQ-R are better measures of successful restraint while the RS measures both successful and unsuccessful restraint. These recent developments have altered the conceptualization of the construct of restrained eating.

Current Perspectives

Traditionally, the concept of restraint has be studied as a unitary phenomenon. However, present evidence suggests that this concept is too inclusive (Heatherton, et al., 1988; Laessle et al., 1989a; Ruderman, 1986; Tuschl, 1990). The current view proposes that restraint is a multifaceted construct consisting predominantly of the intent to restrict food intake and success in achieving this goal (Laessle et al., 1989a; Tuschl, 1990; Westenhoefer, Pudel, & Maus, 1990).

At the present time, only the three aforementioned measures of restraint are available for use in research. Each scale has specific assets and limitations. Laessle et al. (1989a) suggested that the decision as to which scale is an appropriate measure of restraint should be based on the empirical question posed. These authors proposed that the RS is the measure of choice to examine the conditions under which overeating may occur. Therefore, the RS would be the preferred scale in analogue studies of bulimic behavior. This speculation has been borne out by the RS's history of successful prediction of eating behavior in the laboratory, as well as by recent findings in which the TFEQ-R (Lowe & Kleifleld, 1988) and the DBEQ-R (Wardle & Beales, 1987) failed to predict counterregulation. Laessle and his colleagues (1989a) further proposed that when the empirical question involved the investigation of actual caloric restriction of intake, either the TFEQ-R or DEBQ-R would be the measure of choice. The predictive validity of the TFEQ-R and DEBQ-R has been demonstrated by evidence of high correlations between subjects' scale scores and self-reported caloric intake (Laessle et al., 1989b; Tuschl et al., 1990; Van Strien, Frijters, Staveren, Defares, & Deurenberg, 1986; Wardle & Beales, 1987). Thus, the TFEQ-R and DEBQ-R would be preferred when examining the biological or psychobiological consequences of restricted food intake.

There is substantial evidence to indicate that restricting caloric intake by dieting results in a lowered metabolic rate which can persist for some time after normal eating is resumed. There is also some evidence to suggest that repeated bouts of dieting and overeating can produce an enduring decrement in RMR. However, as discussed in the following section, the relationship between RMR and the other component of restraint eating, i.e., episodic disinhibition, has received only limited empirical attention. The relationship between the two components of dietary restraint and metabolic rate has important implications for the development and treatment of disordered eating behavior. To study these variables, measures of both successful and unsuccessful dieting behavior are needed. The TFEQ would appear to be the measure of choice. The questionnaire incorporates a separate 16-item disinhibition of eating scale (TFEQ-D), therefore, allowing independent assessment of both the restrained eating and disinhibition components of dietary restraint. Discrimination between these two components is a relatively new enterprise. Therefore, only preliminary data are available on the relationship between restraint, disinhibition, eating habits, and metabolism.

Dietary Restraint, Disinhibition, and Eating Habits

In a recent seminal article, Tuschl (1990) identified a major theoretical limitation in the research on dietary restraint, specifically, a lack of objective behavioral criteria for the construct. He cogently argued that because restrained eating has been causally linked to binge eating, it must also be linked to specific alterations in eating behavior.

Limited data suggest that restrained eaters consume an average of 300 to 400 kcal/day less than unrestrained eaters do (Laessle et al., 1989b; Tuschl et al., 1990; Van Strien, Frijters, Van Staveren, Defares, & Deurenberg, 1986; Wardle & Beales, 1987). Restrained eaters also tend to display a great deal of variability in intake, alternating between days of high and low energy consumption (Laessle et al., 1989b; Tuschl et al., 1990).

Recently, Tuschl and his colleagues (1990) directly examined energy expenditure in this population. Using the doubly labeled water method, these authors found that normal-weight healthy young women, classified as restrained eaters using the TFEQ-R, expended 620 kcal/day less, and consumed approximately 410 kcal/day less, than their unrestrained counterparts did, after adjusting for body composition and height. These effects did not appear to be due to recent alterations in eating behavior because metabolic indices of starvation, B-hydroxybutyric acid and triiodothyronine (Pirke, & Ploog, 1987) were within the normal range. Rather, findings appeared to reflect diminished energy requirements in restrained subjects, similar to those previously reported in obese, post-obese, anorexic, and bulimic subjects. In the Tuschl et al. (1990) study, restrained subjects tended to be slightly heavier than unrestrained subjects and to report higher maximal former body mass indices. These findings are consistent with previous reports (Devlin et al., 1990; Laessle et al., 1989b; Lowe, 1984) of higher premorbid weights in restrained eaters and suggest that restrained eaters may attempt to maintain their weights below biologically predetermined levels as restraint theory would predict (Polivy & Herman, 1985). Therefore, decline in metabolic rate and increased energy efficiency may be consequences of a restrained eating style. Furthermore, repeated cycles of weight loss and regain, or the combination of intermittent over and undernutrition, i.e., chaotic eating, may contribute to reduced energy expenditure.

The finding that restraint accounted for 47% of the variability in energy expenditure (Tuschl et al., 1990) points to the importance of assessing dieting behavior when examining energy requirements in normal and eating-disordered subjects. Metabolic differences between successful and unsuccessful dieters may be of prognostic significance in identifying individuals at risk for developing obesity and eating disorders.

Recent evidence suggests that restrained eaters are a heterogenous group in terms of their eating behavior. A group of German researchers have examined the relationship between restraint, disinhibition, and eating disturbances. Westenhoefer, Pudel, and Maus

(1990) cite data collected and published in Germany which indicated that, out of a survey of 1,000 women, 92% of the women who dieted intermittently but frequently reported problems with eating behavior. In contrast, only 58% of the women who dieted permanently reported eating problems. Results suggested that intermittent dieting and overeating (chaotic eating) may lead to eating disturbances. Furthermore, while a large number of restrained eaters are unsuccessful dieters and tend to fluctuate between periods of caloric restriction and overeating, there is a subgroup of restrained eaters who are successful dieters and manage to maintain consistent restraint and lowered weight levels. This subgroup of restrained eaters failed to demonstrate counterregulation in the laboratory (Lowe & Kliefield, 1988; Wardle & Beales, 1987, 1988) and would tend to be at low risk for developing bulimic behaviors. Therefore, intended restraint, actual restriction of intake, and disinhibition of eating may be important variables in understanding disordered eating behavior.

Pudel and Westenhoefer (1989a, cited in Westenhoefer, Pudel, & Maus, 1990) reported low correlations between the restraint and disinhibition factors of the TFEQ in German populations. Pudel and his colleagues identified a substantial number of subjects with very low and very high scores on the disinhibition factor, even among highly restrained subjects. In a study of over 35,000 readers of German women's magazines, Westenhoefer & Pudel (1989, cited in Westenhoefer, Pudel, & Maus, 1990) found that body mass index was dependent upon both restraint and disinhibition scores. The relationship is depicted in Figure 1. Similarly, Pudel & Westenhoefer

(1989b, cited in Westenhoefer, Pudel, & Maus, 1990) found evidence of a two-way influence of restraint and disinhibition on energy intake in a study of 46,769 subjects prior to entering a weight reduction program. A graphic representation of these results is presented in Figure 2. Results of these studies indicated that mean daily intake and body mass index were highest in subjects receiving high disinhibition and low restraint scores. BMI was lowest in subjects receiving low restraint and low disinhibition scores and was intermediate in subjects receiving high restraint/high disinhibition and high restraint/low disinhibition scores. In contrast, mean daily intake was lowest for subjects receiving high restraint/low disinhibition scores and was intermediate for subjects receiving high restraint/high disinhibition scores and low restraint/low disinhibition scores. Findings suggested that decreased intake does not necessarily result in a smaller body size.

The finding of varying weight levels across both restrained and unrestrained eaters is in contrast to Laessle et al.'s (1989b) finding of higher body weights in restrained eaters. Westenhoefer et al. (1990) suggested that the discrepant findings may be accounted for by the fact that Laessle and his colleagues found that restrained subjects had significantly higher disinhibition scores than unrestrained subjects had. Thus the finding of higher body mass indices among restrained eaters may have been due to the correlation between restraint and disinhibition in the Laessle sample.

Because restrained eaters who are prone to overeating may differ from those who are not, it is important to identify the specific

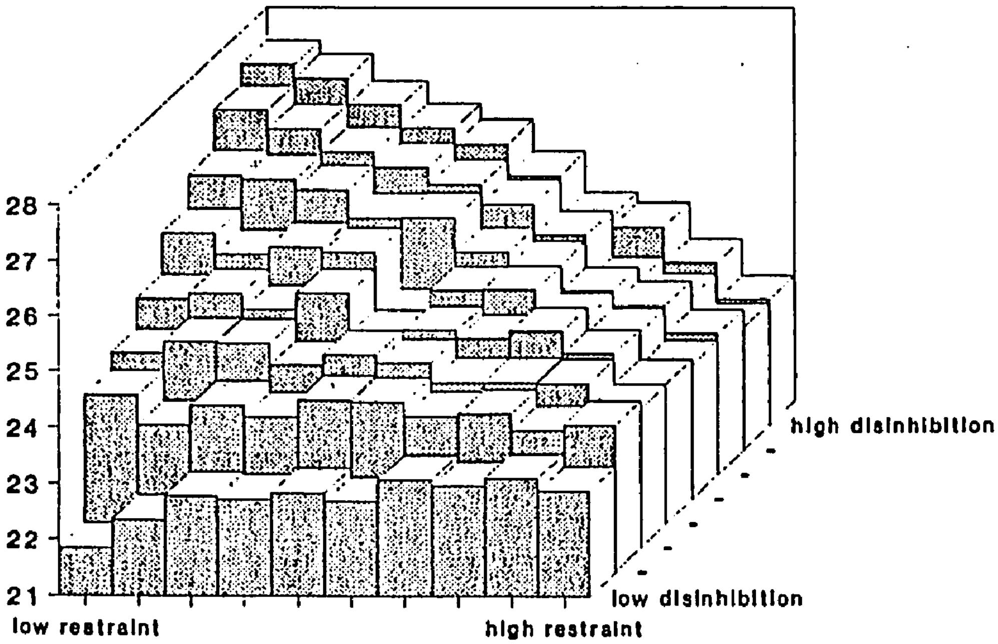

FIGURE 1. Mean body mass index (BMI) in several subgroups with varying restraint and disinhibition. Results from a study of 35,000 readers of a women's magazine.

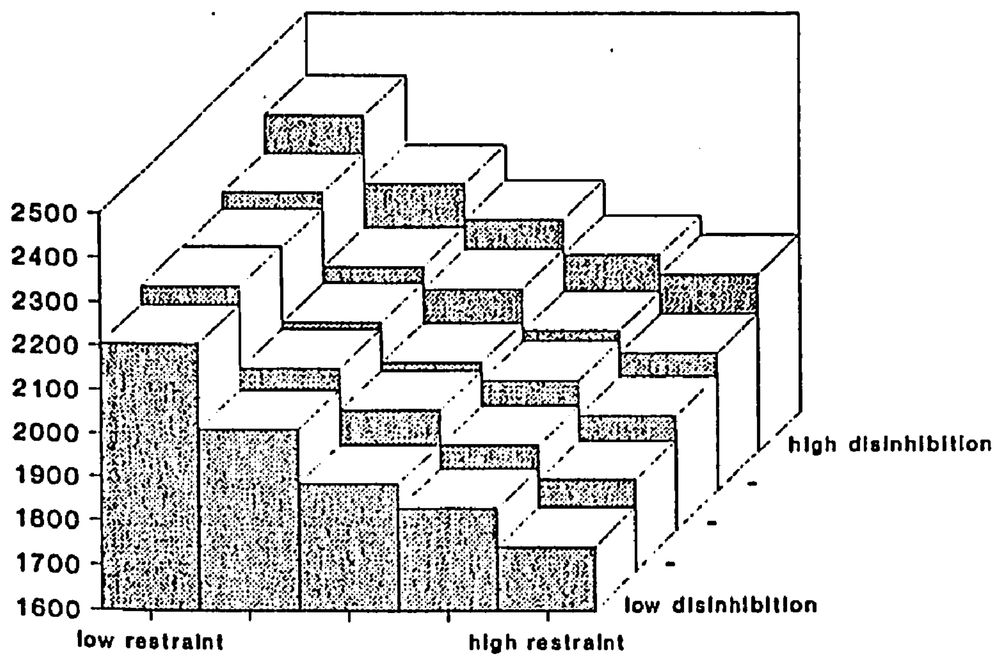

FIGURE 2. Mean daily energy intake (kcal/day) in several subgroups with varying restraint and disinhibition. Results from a study with 46,769 participants at the beginning of a weight-reduction program.

Reproduced from: Westenhoefer, J., Pudel, V., & Maus, N. (1990). Some restrictions on dietary restraint. Appetite, 14, 137-141.

dietary practices and collateral variables which render certain dieters vulnerable to overeating and binge eating. Current evidence suggests that disinhibition of eating is an important factor to be considered when examining dieting behavior. This variable tends to discriminate between successful and unsuccessful dieters. Metabolic differences between successful and unsuccessful dieters may be of prognostic significance in identifying individuals at risk for developing eating disorders.

Recent data suggest that bulimics and normal-weight restrained eaters have similar and significantly higher levels of restraint, as measured by the RS (Rossiter, Wilson, & Goldstein, 1989) and TFEQ-R (Laessle, Tuschl, Waadt, & Pirke, 1989; Rossiter et al., 1989), than do normal-weight unrestrained eaters. Findings suggest that bulimics and non-bulimic restrained eaters are quite similar in terms of restraint, preoccupation with food, and dissatisfaction with their weight and their bodies. In contrast, bulimic subjects received significantly higher TFEQ disinhibition scores than did restrained eaters, who in turn received significantly higher scores than unrestrained eaters did (Laessle et al., 1989; Rossiter et al., 1989). Loss of control over eating was highest in bulimics but elevated in restrained eaters relative to unrestrained subjects. Thus it appears that restrained eating itself is a necessary but insufficient condition for the development of disordered eating behavior (Tuschl, 1990; Westenhoefer et al., 1990).

Because restraint theory hypothesizes that restrained eaters maintain a body weight that is below a biologically determined set-point, perhaps assessment of the biological correlates of dieting may provide some clues as to how eating disorders develop and are maintained. There is evidence to suggest that a subgroup of overweight women may be resistant to slimming (Miller & Parsonage, 1975; Ravussin et al., 1988). Conceivably, restrained eaters may have a lowered RMR and require fewer calories to maintain their weight. Such a biological predisposition to weight gain would present a frustrating situation for chronic dieters. The more pronounced the suppression of RMR, the more vulnerable such individuals would be to resorting to more extreme methods of weight control, such as even more severe restrictive dieting, laxative abuse, and self-induced vomiting, i.e., behaviors characteristic of eating disorders. These behaviors could in turn lead to disturbances over the control of eating itself, i.e., binge eating, as restraint theory hypothesizes.

It is also possible that restrained women who maintain tenuous control over eating, i.e., fluctuate between periods of restraint and disinhibition of eating, would be at greater risk for developing a full-fledged eating disorder. High levels of restraint, in conjunction with high levels of disinhibition of eating, may pose the highest risk factor. Subclassification of restrained eaters in terms of degree of restraint and disinhibition may help to identify biological differences between restrained eaters who are able to maintain control over their eating and those who develop bulimic behavior. Such findings could be of prognostic importance in identifying individuals at risk for developing eating disorders. Therefore, examination of the metabolic effects of alterations in energy intake and expenditure may provide support for the speculation that cycling between periods of dieting and overeating (chaotic eating) may pose a greater risk factor than intact restraint.

Summary and Conclusions

The foregoing discussion has shown that dieting is prevalent among women in our society. There is substantial evidence to suggest that dieting is causally linked to eating disturbances. It is possible that individuals prone to develop eating disorders have a biological predisposition to obesity. This predisposition may be resisted by extreme methods of weight control which ultimately break down and lead to periods of overeating. Restriction of intake has been shown to enhance energy efficiency as manifested by a lowered metabolic rate. Weight cycling may also be related to this metabolic adaptation, whereby weight fluctuation from recurrent episodes of dieting may provide the biological factor leading to the increased probability of disordered eating. Recent evidence also suggests that a history of erratic or chaotic eating may be a more important factor than intact dietary restraint in the development of binge eating.

Measures of the construct of dietary restraint have been shown to have utility in the study of behavioral and biological correlates of eating disturbances. The TFEQ appears to the particularly well-suited to the study of the relative contributions of successful and unsuccessful dietary practices because this scale incorporates independent assessment of both dietary restraint and disinhibition of eating. Investigation of differences between successful and unsuccessful dieters in terms of resting metabolic rate may provide support for the speculation that chaotic eaters are more prone to develop eating disorders than successful dieters because of a biological predisposition to obesity that follows from this eating pattern. Findings would also have important implications for identifying individuals at risk for developing eating disorders, as well as implications for interpreting the results of previous studies examining resting metabolic rate in obese and normal-weight populations. The traditional use of a generic lean or normal-weight comparison group may be inappropriate given the heterogeneity among "normal" eaters in terms of restraint.

Research Questions and Hypotheses

The present study examined resting metabolic rate in normal female subjects classified as to their degree of successful and unsuccessful dieting practices. A 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) factorial design, using scores on the restraint and disinhibition scales of the TFEQ, was used to identify four groups of normal female subjects. Group 1 was composed of subjects with high restraint and high disinhibition scores (HR/HD). These subjects were individuals who alternately gained and lost control over their eating (i.e., chaotic eaters). Group 2 was composed of subjects with high restraint and low disinhibition scores (HR/LD). These subjects were individuals who were successful in maintaining restrictive control of their eating (i.e., restrained eaters or successful dieters). Group 3 consisted of subjects with low restraint and low disinhibition scores (LR/LD). These women were supranormal eaters who never dieted of lost control of their eating.

Group 4 consisted of subjects with low restraint and high disinhibition scores (LR/HD). These women were individuals who were unable to maintain control of their eating and frequently overate. This group could be described as uncontrolled overeaters.

While the present study was exploratory in nature, the following predictions were made. If self-imposed reduced caloric intake, i.e, successful dieting or restraint, wass the predominant variable influencing metabolic rate, RMR would be lower in individuals who restrictively controlled their eating than in individuals who did not. Increased weight is an inevitable consequence of loss of control over eating with recurrent overeating. Therefore, if loss of control over eating, i.e., disinhibition of eating, was the more important variable, RMR would be higher in individuals who frequently lost control of their eating, and were heavier, than in thinner individuals who did not lose control of their eating. Finally, if dieting and disinhibition interacted to influence RMR, RMR would be highest in normal eaters who did not attempt to control their eating and lowest in subjects who fluctuated between periods of control and loss of control. In addition, caloric intake was expected to be lowest in individuals who maintained consistent control over their eating and highest in individuals who never had control and frequently overate. Similarly, body weight and tendency toward binge eating were expected to be highest in individuals who were unable to maintain control and recurrently overate, and lowest in individuals who maintained consistent restrictive control of their eating.

Method

Subjects

Normal female subjects were recruited from undergraduate psychology classes at Louisiana State University and from a community sample responding to newspaper articles and advertisements about the study. The study was part of a larger research project conducted at the Pennington Biomedical Research Center of LSU. Subjects were selected from a pool of 523 candidates who ranged in age from 17 to 70. All subject candidates completed the Three Factor Eating Questionnaire (TFEQ, Stunkard & Messick, 1985) and a medical screening questionnaire (Personal History Questionnaire). Potential subjects were selected to be equivalent in age and were identified on the basis of their scores on the restraint and disinhibition scales of the TFEQ. Only subjects scoring below the 30^{th} percentile, or above the 70^{th} percentile, in the distribution of scores on each scale were eligible. Subjects scoring 13 or higher, and 6 or lower, on the TFEQ-R were classified as high and low restraint, respectively. Subjects scoring 12 or higher, and 6 or lower, on the TFEQ-D were classified as high and low disinhibition, respectively. Extreme groups were selected to assure adequate discrimination between high and low levels of the two independent variables.

Potential subjects who were healthy, free from thyroid and respiratory disease, not taking antidepressant medication, premenopausal, and having regular menstrual cycles were contacted. The procedures and requirements of the four-week study were explained to them in detail. Forty-four subjects in one of four categories:

high restraint, high disinhibition (HR/HD) (N=10); high restraint, low disinhibition (HR/LD) (N=11); low restraint, low disinhibition (LR/LD) (N=12); and low restraint, high disinhibition (LR/HD) (N=11) volunteered to participate in the study. For their participation, subjects were paid $75 and provided with feedback of their results. Student subjects also received extra course credit. All 44 subjects completed all components of the study.

Description of Groups. The relatively small number of subjects prevented a large number of multivariate analyses of the data. Therefore, multiple 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) univariate analyses of variance were used for descriptive analyses of demographic data. To ameliorate Type 1 error, significance is reported at the .01 level.

Group means and standard deviations for demographics are summarized in Table 1. The demographic variables that were statistically analyzed included age, height, weight, Body Mass Index (BMI), and caffeine consumption. Body mass index is a crude anthropometric measure of nutritional status and body fatness. BMI was calculated as weight in kg/height in meters^2.

Subjects were between the ages of 18 and 49. There were no significant differences between the groups in age, height, and caffeine consumption. However, HD subjects tended to be older than LD subjects. Examination of group means for caffeine consumption indicated a great deal of variability in caffeine intake. Nonetheless, groups means suggested that, on the average, subject's caffeine consumption was not excessive and should not have

Table 1

Group Means and Standard Deviations for Demographics[a]

	Group[b]			
Variable	HR/HD	HR/LD	LR/LD	LR/HD
Age (yr)	37.00 (8.71)	32.91 (10.48)	28.92 (9.17)	36.18 (8.39)
Height (cm)	164.05 (6.72)	164.05 (6.47)	166.91 (6.54)	165.29 (6.62)
Weight (kg)	74.72[a] (12.99)	62.68[a] (15.74)	53.16[a] (6.15)	103.65[b] (37.52)
BMI (wt/ht^2)[c]	27.88[a] (5.57)	23.13[ab] (4.90)	19.07[b] (1.77)	37.45[c] (12.46)
Caffeine (mg)	194.50 (215.59)	272.00 (548.70)	117.67 (93.79)	173.45 (118.78)

[a]Means with different letters are significantly different (p<.01).

[b] HR/HD = High Restraint/High Disinhibition

HR/LD = High Restraint/Low Disinhibition

LR/LD = Low Restraint/Low Disinhibition

LR/HD = Low Restraint/High Disinhibition

[c]Weight in kilograms, height in meters

significantly affected interpretation of RMR results.

In contrast to other demographics, there were significant differences between the groups in terms of weight. A significant main effect for disinhibition, F (1,40) = 23.17, p < .0001, and interaction effect, F (1,40) = 8.76, p < .005, were found. LR/HD subjects were significantly heavier than the other groups. While not significantly different, HR/HD subjects weighed more than HR/LD subjects, who in turn, weighed more than LR/LD subjects. There also were significant differences between the groups in Body Mass Index (BMI). A significant main effect for disinhibition, $\underline{F}$ (1,40) = 27.84, $\underline{p}$ < .0001, and a significant interaction effect, $\underline{F}$ (1,40) = 9.65, $\underline{p}$ < .003 were found. LR/HD subjects had significantly higher BMIs than the other groups. BMI for HR/HD subjects was significantly higher than for LR/LD subjects, but did not differ from that for HR/LD subjects. BMI for HR/LD subjects was also similar to that for LR/LD subjects. Based on an ideal BMI of 22 (Tokunaga et al., 1990), and obesity defined as a BMI greater than 27 (Gray, 1989; Obesity & Health, January/February 1991), results indicated that LR/LD subjects were below ideal weight, while HR/LD subjects were slightly above ideal weight. In contrast, the two HD groups were significantly above ideal weight and would be classified as obese.

Low frequencies across the groups in race, smokers, and subjects taking oral contraceptives prevented statistical analyses of these variables. Group frequencies are shown in Table 2. The majority of subjects were white. Four of the five black subjects were in the HR/HD group. Only five subjects were smokers. Ten of the 44 subjects were taking oral contraceptives. These low frequencies, and the distribution of the variables across groups, suggested that these variables also should not interfere with interpretation of RMR results.

Table 2

Group Frequencies for Race, Smokers, and Use of Oral Contraceptives

Variable	HR/HD (N=10)	HR/LD (N=11)	LR/LD (N=12)	LR/HD (N=11)
Race - White	6	9	11	11
Black	4	1	0	0
Other	0	1	1	0
Smokers	1	1	2	1
Oral Contraceptives	2	2	4	2

None of the subjects met the DSM-III-R diagnostic criteria for anorexia or bulimia as assessed by the Interview for Diagnosis of Eating Disorders (Williamson, 1990). One subject in the HR/HD group, and one subject in the LR/HD group, met the criteria for a diagnosis of compulsive overeating. One subject in the LR/HD group met the diagnostic criteria for atypical eating disorder with bulimic features.

Representativeness of the Sample

To determine whether the selected sample differed from the larger sample of potential subject candidates, a 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) X 2 (Sample) analysis of variance was performed. Variables examined included age, weight, BMI, TFEQ-R, and TFEQ-D scores. The analysis yielded a significant disinhibition by sample interaction effect, F (5,194) = 3.20, $p < .008$. Results of univariate analyses indicated a significant main effect for sample for TFEQ-R scores, F (1,198) = 5.22, $p < .02$. The interaction effects for TFEQ-R scores, F (1,198) = 4.73, $p < .03$, and TFEQ-D scores, F (1,198) = 7.38, $p < .007$, were also significant. Means and standard errors for the designated variables as a function of sample and disinhibition are shown in Table 3.

Table 3

Means and Standard Errors for Designated Variables as a Function of Sample and Disinhibition[a]

	Sample			
	Selected Subjects		Subjects Not Selected	
Variable	HD (N=23)	LD (N=21)	HD (N=65)	LD (N=97)
Age (yr)	36.59±2.70	30.91±2.58	41.79±1.55	29.69±1.26
Weight (kg)	89.18±4.26	57.92±4.07	86.93±2.44	63.72±1.99
BMI (wt/ht^2)	32.67±1.60	21.10±1.53	32.72±0.92	23.44±0.75
TFEQ-R	9.96±0.44[a]	11.22±0.42[b]	9.93±0.25[a]	9.70±0.20[a]
TFEQ-D	14.09±0.32[a]	3.53±0.30[b]	13.31±0.18[c]	4.12±0.15[b]

[a]Means with different letters are significantly different ($p<.05$).

Low disinhibition subjects who were selected had significantly higher TFEQ-R scores than did high disinhibition subjects who were selected and both groups of subjects that were not selected. While the difference (11.2 vs 9.9) was statistically significant, a one-point difference does not represent practical significance. TFEQ-D scores did not differ in the low disinhibition groups of the two samples. However, high disinhibition subjects who were selected had significantly higher TFEQ-D scores than did high disinhibition subjects who were not selected (14.1 vs 13.3). Again, this difference is not of practical significance. There were no significant differences between the samples in terms of age, weight, or BMI. Overall findings suggested that subjects in the selected sample were more similar than dissimilar to the larger sample from which they were chosen for inclusion in the study.

Assessment Measures

Three Factor Eating Questionnaire (TFEQ). The TFEQ (Stunkard & Messick, 1985), which can be found in Appendix A, is a 51-item self-report questionnaire designed to measure three dimensions of eating behavior: Scale I - cognitive restraint (21 items); Scale II - disinhibition of eating (16 items); and Scale III - perceived hunger (14 items). Stunkard and Messick (1985) demonstrated high reliabilities for the three scales (coefficient alphas: 0.93, 0.91, 0.85, respectively). Evidence of a significant inverse correlation between subjects scores on the TFEQ-R and self-reported caloric intake ($r = -.45$, $p < .001$) argues for the validity of the restraint scale (Laessle et al., 1989b; Tuschl et al., 1990). Validity of the disinhibition scale is supported by a significant correlation between obese subjects' TFEQ-D scores and their scores on the BES, a measure of binge eating tendency ($\underline{r}$ = .61, $\underline{p}$ <.001) (Marcus, Wing, & Lamparski, 1985).

Bulimia Test (BULIT). The BULIT (Smith & Thelen, 1984), found in Appendix B, is a 36-item, self-report scale designed to identify bulimic symptoms in normal and eating-disordered populations. The scale has proven reliability and validity. A coefficient alpha of .94 has been reported in a university sample (Wertheim, 1989). Two-month test-retest reliability was .87 (Smith & Thelen, 1984). Validity of the scale has been demonstrated by reports of a significant correlation ($\underline{r}$ = .93, $\underline{p}$, < .001) between subjects' scores on the BULIT and Binge Scale, a measure of binge eating tendency (Hawkins & Clement, 1980). In terms of predictive validity, the BULIT has been show to successfully discriminate between normal, bulimic, and obese subjects (Williamson, Prather, McKenzie, & Blouin, 1990; Smith & Thelen, 1984).

The BULIT has been shown to consist of five or six factors in various college populations (Smith & Thelen, 1984; Stein, & Brinza, 1989; Thelen, Mann, Pruitt, & Smith, 1987; Wertheim, 1989). The factors are generally labeled binging, vomiting, feeling, food, weight, and menstruation. The binging factor typically accounts for at least 60% of the variance in total BULIT scores (Thelen et al., 1987). The authors of the BULIT recommend a cutoff score of 88 when screening for bulimic symptomatology (Smith & Thelen, 1984).

Eating Attitudes Test (EAT). The EAT (Garner & Garfinkel, 1979), found in Appendix C, is a 40-item, 6-point, forced choice, self-report scale which measures anorexic attitudes and behaviors. The internal consistency of the scale is adequate. Garner, Olmsted, Bohr, and Garfinkel (1982) and Racciti and Norcross (1987) reported coefficient alphas of .83 and .86, respectively, in university samples. The scale also has proven utility in identifying college students with abnormal concerns about eating and weight (Button & Whitehouse, 1981). The EAT has been shown to discriminate anorexics and bulimics from normal subjects (Garner & Garfinkel, 1979; Garner et al., 1982; Gross, Rosen, Leitenberg, & Willmuth, 1986). The scale is composed of three factors: dieting, bulimia and food preoccupation, and oral control. The authors recommend a cutoff score of 30 when screening for anorexic behaviors (Garner & Garfinkel, 1979).

Eating Questionnaire - Revised (EQ-R). The EQ-R, which can be found in Appendix D, is a 15-item, multiple choice, self-report scale designed to assess the DSM-III criteria for bulimia. A test-retest reliability of .83 and coefficient alpha of .87 have been reported (Williamson, Davis, Goreczhny, McKenzie, & Watkins, 1989). EQ-R scores are highly correlated with BULIT scores (r = .80) and have been shown to discriminate bulimics from normals (Williamson et al., 1989).

Eating Disorder Inventory (EDI). The EDI, found in Appendix E, is a 64-item, six-point, forced choice, multiscale, self-report inventory designed to assess psychological and behavioral characteristics of anorexia and bulimia. The EDI consists of eight subscales: 1)Drive for Thinness (EDI-DT), 2)Bulimia (EDI-B), 3)Body

Dissatisfaction (EDI-BD), 4)Ineffectiveness (EDI-I), 5)Perfectionism (EDI-P), 6)Interpersonal Distrust (EDI-ID), 7)Interoceptive Awareness (EDI-IA), and 8)Maturity Fears (EDI-MF). Internal consistency for each subscale was above .80 in a sample of normal and anorexic subjects (Garner & Olmsted, 1984). The scale has been shown to discriminate normals from anorexics (Garner & Olmsted, 1984) and from bulimics (Gross, Rosen, Leitenberg, & Willmuth, 1986). Significant correlations between clinicians' ratings and EDI scores have also been reported (Garner & Olmsted, 1984).

Personal History Questionnaire. This 25-item self-report questionnaire, found in Appendix F, is comprised of selected items from the Diagnostic Survey for Eating Disorders (DSED, Johnson, 1985) and the Diet Assessment Form which was constructed by Dr. Paula Howat of LSU for use at Pennington Biomedical Research Center. The questionnaire assesses subject's customary intake of caffeine and nicotine; medical history, including thyroid disease, respiratory disease, and pregnancy; current medications, including antidepressants and birth control pills; menstrual history; personal diet and weight history; and family history of obesity. Information obtained from the questionnaire was used to exclude potential subjects from the study. Potential subjects who were pregnant, who reported a history of thyroid or respiratory disease, or who were currently taking antidepressant medication were excluded.

The questionnaire also provided several dependent variables for the study. Information on subject's highest nonpregnant weight, lowest adult weight, weight range, recent weight loss or gain, number of diets within the past year, number of weight cycles of more than 10 pounds, and positive personal and family history of obesity was derived from the Personal History Questionnaire.

Interview for Diagnosis of Eating Disorders (IDED). This semi-structured interview, found in Appendix G, was designed to assess the symptoms of anorexia nervosa, bulimia nervosa, and compulsive overeating (Williamson, 1990). Rating scales provide information consistent with the DSM-III-R diagnostic criteria for anorexia and bulimia nervosa and a modification of the DSM-III criteria for bulimia, describing compulsive overeating. The interview has been shown to be a reliable and valid diagnostic tool. All subscale reliabilities exceeded 0.90 (Williamson, Davis, Norris, & Van Buren, 1990). The IDED was used to exclude potential subjects who manifested the eating disorders of anorexia and bulimia nervosa.

Food Record. The food record can be found in Appendix H. The food record was developed by Dr. Paula Howat of LSU for use at Pennington Biomedical Research Center. In the food record, subjects recorded each eating episode when it occurred. They completed a separate form for each eating episode. In addition to the type of food and amount eaten, subjects also recorded the day, date, and time that each eating episode occurred. For each eating episode, they rated the amount of consumption from an undereat to a binge. Instructions for completing the food record, and an example of a completed page, were provided to the subjects in the front of each food record booklet.

To enhance the reliability and validity of the food monitoring data, subjects were extensively trained and drilled in proper food weighing and measurement before data collection began. All training, record review, and remediation were conducted by a doctoral level nutritionist and an upper level nutrition graduate student at LSU. Subjects were encouraged to keep complete, accurate food records and were required to complete 14 days of food monitoring before metabolic assessment.

Dietary intake data obtained from the food record were coded and analyzed using the Extended Table of Nutrient Values (ETNV) developed by Dr. Margaret Moore of the LSU School of Medicine and Mary Helen Goodloe of the Georgia Department of Public Health. ETNV is an extensive USDA-based data system containing over 2,500 individual foods and more than 2,000 recipes, many native to southeast Louisiana cuisine. The database is continually updated.

Several dependent variables were obtained from subjects' food records. Average daily calorie intake was calculated from the 14 days of monitoring. This variable was used to represent a general index of restrained or disinhibited eating style. Similarly, the ratio of each subject's three highest calorie days to three lowest calorie days, the number of days when intake was below 800 calories, and the number of days when intake was above 2,500 calories, were derived. These upper and lower limits were based on the suggested RDA for women in the subjects' age range (National Research Council, 1989). The number of self-reported undereating and overeating episodes, snacks, meals, and dietary fat, carbohydrate, and protein were also examined.

Activity Record. A modification of the California Diet Plan Activity Monitor (Wood, 1983), designed for use at Pennington Biomedical Research Center, was used to assess subjects' ratings of their activity. The activity record can be found in Appendix I. Subjects recorded their activity level (0-5) at hourly intervals over a one-week period preceding metabolic assessment. Levels of activity ranged from sleeping to heavy exertion. Before completing the record, subjects were provided with examples of activities at each level. A copy of these instructions was included in the each subject's activity record booklet. Data from the week of monitoring were converted to kcals using the standard metabolic calculations prescribed by the American College of Sports Medicine (1991). Results were expressed as average daily caloric expenditure (kcal/24hr).

Assessment Procedures

Indirect calorimetry. An open circuit indirect calorimetry system (SensorMedics 2900Z Portable Metabolic Cart) utilizing a ventilated hood was used for metabolic testing. The principle of the procedure and measurement techniques were described in the previous section on measurement of metabolic rate. The calorimetry system was interfaced with a microcomputer. Software computations for resting metabolic rate were based on the formulas derived by Weir (1949). Readings of RMR were taken at one minute intervals over a 30-minute period. Readings were averaged and expressed in absolute values as kcal/24 hours.

RMR has frequently been reported as a function of lean body mass (Bessard, Schutz, & Jequier, 1983; Devlin et al., 1990; Wadden et al., 1990; Weststrate, Dekker, Stoel, Begheijn, Deurenberg, & Hautvast, 1990). However, the preferred method for diminishing the effect of random individual differences in a variable which is related to the independent variable of interest, is to covary out this variable's effect on the dependent variable. Analysis of covariance statistically adjusts for differences in a covariate by partialling out the effect of the covariate before the effect of the independent variable on the dependent variable is assessed. The outcome of this adjustment is a more powerful test of differences between the groups (Tabachnick & Fidell, 1983). Group means were statistically adjusted and analyzed to determine the effect of FFM on RMR. Resting metabolic rate as a function of fat-free mass was calculated as kcal/kg FFM/24hr and also analyzed.

Body weight and composition. Subject's weight in kilograms was determined using a Detecto digital scale. Height was measured in centimeters using a stadiometer.

Because of the significance of lean body mass in determining resting metabolic rate, and the inconsistency across methods of assessment reported by other researchers (Devlin et al., 1990), three separate procedures were used to determine body fat and FFM. The first method for determining body composition, hydrostatic or underwater weighing (UWW), has been used as a reference method to which others measures are compared. The method is based on Archimedes principle of water displacement. The weight of displaced water, which represents body density, is equal to the difference between body weight measured in air and weight measured during water submersion.

Body density is equal to the loss of weight in water with the appropriate correction for the water's density.

Underwater weighing permits discrimination between body fat and fat-free mass (FFM). Body density lies between the density of fat (0.90 g/cm^3) and fat-free mass (1.10 g/cm^3) (Katch & McArdle, 1983). The Siri equation utilizes these values to calculate percent body fat (Siri, 1961). The procedure requires that underwater weight be taken following maximal exhalation with measurement of residual lung volume (Katch & McArdle, 1983). Residual lung volume was determined using the helium dilution technique (Meneely et al., 1960). Ten five-second trials of underwater weighing were conducted following maximal exhalations. Results were averaged and reported as percent body fat. FFM was calculated as body weight minus fat mass.

The second method for assessing body composition, bioelectrical impedance (BIA), is based on the principle that electrical conductivity of lean tissue is far greater than that of fat tissue (Lukaski, Johnson, Bolonchuk, & Lykken, 1985). There is sufficient evidence to support the use of this method as a reliable and valid measure of body fat (Boulier, Fricker, Thomasset, & Apfelbaum, 1990; Deurenberg, Weststrate, & Hautvast, 1989; Lukaski et al., 1985; Pirke, Muenzing, Moser, & Beumont, 1989; Segal, Van Loan, Fitzgerald, Hodgdon, & Van Itallie, 1988).

The BIA-101A (RJL Systems, Detroit Michigan) body composition analyzer was used to determine body fat. For assessment, subjects were placed in the supine position with their right side to the analyzer. Four electrodes, two on the right hand and two on the right foot, were attached to the subject. An 800 microamp current was applied. Resistance (ohms/cm) to the flow of current was measured. Percent body fat was calculated using the regression equation for females developed by Gray and his colleagues (Gray, Bray, Gemayel, & Kaplan, 1989). The equation was deemed appropriate for the present study because it was developed from a sample of adults who varied widely in body composition (9-59% body fat).

The final technique for determination of body composition utilized anthropometry or skinfold measurement (SF). Subject's skinfold measurements were assessed using Lange skinfold calipers (Cambridge Scientific Industries). Three skinfold measurements were taken at each of six sites: triceps, biceps, subscapular, suprailiac, abdominal, and medial calf. Percent body fat was calculated by adding the average measurements from the first four of these six sites using a modification of the method of Durnin & Womersley (1974). This procedure was provided by the manufacturer of the Lange calipers. A major limitation of skinfold measurement is that examiners must have considerable experience with the procedure to obtain accurate and reliable results (Katch & McArdle, 1983). One well-trained and experienced doctoral level nutritionist collected all skinfold data.

Activity meter. As an objective measure of caloric expenditure from physical activity, subjects wore the Caltrac Personal Activity Computer (Caltronics Division of Hemokinetics, Inc.) for a one-week period prior to metabolic testing. The Caltrac is an electronic device which continually measures and records activity level by sensing vertical body movement. The device uses an accelerometer to estimate caloric expenditure. When the body accelerates upward, a half-inch ceramic, cantilevered beam bends and emits a current proportional to the force acting on it. A computer in the unit can be used to plot an acceleration curve and calculate caloric expenditure based on resting metabolic rate. The instrument has been shown to have adequate reliability and validity for estimating energy expenditure from physical activity (Hunter, Montoye, & Demment, Ji, & Ng, 1989; Montoye, Washburn, Servais, Ertl, Webster, & Nagle, 1983; Pambianco, Wing, & Robertson, 1990; Washburn, Cook, & Laporte, 1989).

In the present study, the Caltrac was used to obtain raw activity counts. Subjects recorded these counts at hourly intervals over a one-week period. Counts were converted to energy expenditure using standard metabolic calculations (American College of Sports Medicine, 1991) and then used to calculate energy expenditure based on each subject's measured resting metabolic rate. Average daily caloric expenditure from the Caltrac was expressed as kcal/24 hours.

Procedure

Potential subjects who agreed to participate in the study attended a final screening session at Pennington Biomedical Research Center. At this session, they were interviewed using the IDED and completed the BULIT, EAT, EQ-R, and EDI. All subjects who attended this final screening remained eligible to participate. During this session, each subject was scheduled for the remaining sessions of the four-week study. Metabolic testing was scheduled to take place within the two weeks after the predicted first day of each subject's next menstrual cycle.

Week 1 of the study consisted of an initial three-hour training and practice session in food measurement and recording. Subjects were provided with a scale and measurement utensils to use during the study. The session was conducted at the LSU department of Human Ecology. Subjects returned to LSU two days after training for a follow-up session to review practice food records before actual data collection began.

Week 2 of the study involved continued food recording with a review session at the end of the week to verify that records were complete and to remediate any problems. During Week 2, subjects' initial weights and heights were obtained. Subjects were also instructed how to use the Caltrac activity meter, and how to complete the activity record, which they completed during Week 3.

During Week 3, subjects recorded readings from the Caltrac, and subjective ratings of their activity level, at hourly intervals. They continued to keep food records. During this week, subjects also attended a session for assessment of body composition, i.e., underwater weighing, bioelectrical impedance, and skinfold measurement. Weights were again obtained at this session. Subjects reported to the session at Pennington Biomedical Research Center at 8 A.M. following a 12-hour overnight fast.

During the final week of the study, subjects returned their food records, Caltrac, and activity records. All records were reviewed for accuracy and completeness. Each subject's final session consisted of measurement of resting metabolic rate. On the day of metabolic testing, subjects reported to Pennington Biomedical Research Center at

7 A.M. after a 12-hour overnight fast. Subjects were instructed to get a good night's sleep, to refrain from vigorous physical activity during the day prior to testing, and to engage in only minimal sedentary activity before arrival at the lab. Smokers were instructed to refrain from smoking on the morning of assessment. Compliance with pretesting instructions was assessed by interview. Only one subject failed to comply with instructions and was rescheduled for metabolic testing.

At this final session, subjects were weighed again to determine their weight stability during the two weeks prior to metabolic testing. For metabolic measurement, subjects were placed in the supine position in a climatically controlled room and allowed to rest for 30 to 60 minutes. Subjects acclimated to the ventilated hood for approximately 30 minutes prior to actual measurement of resting metabolic rate. Resting metabolic rate was measured at one-minute intervals over a 30-minute period. Readings were averaged and reported as kcal/24hr.

Summary of Dependent Variables

Subjects' scores on the TFEQ-R and TFEQ-D comprised the two independent variables in the study. The principal dependent variable was resting metabolic rate as determined by open circuit indirect calorimetry. Other dependent variables included percent body fat determined by underwater weighing, bioelectrical impedance, and skinfold measurement, fat mass, and fat-free mass calculated from percent body fat as determined by underwater weighing.

The relationships between RMR and various weight-related variables, expenditure variables, and intake variables were examined. Weight variables included current weight, BMI, self-reported recent weight gain or loss, highest premorbid nonpregnant weight, lowest adult weight, weight range, number of weight cycles of more than ten pounds, and positive personal and family history of obesity.

Energy expenditure, expressed as kcal/day, was obtained from the activity record and Caltrac. It was expressed in two forms: an absolute value and an adjusted measure that controlled for body weight. Finally, several behavioral restraint/disinhibition variables were derived from subject's food records. Average daily caloric intake and the ratio of three highest to three lowest calorie days represented general indices of restrained and disinhibited eating behavior. Other behavioral indices of restraint included the number of self-reported undereats, the number of days when intake was below 800 calories, and the number of times each subject began a diet within the past year. Further indices of disinhibition included the number of days when intake was above 2,500 calories and the number of self-reported overeats. The number of snacks and meals, and percentages of calories derived from fat, carbohydrate, and protein, were also examined.

Results

Psychological Assessment

Multiple 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) univariate analyses of variance were performed on psychological assessment measures. Statistical significance is reported at the .01

level. Psychological assessment measures examined included subjects' scores on the Three Factor Eating Questionnaire (TFEQ) restraint, disinhibition, and hunger scales, Bulimia Test (BULIT) and BULIT binge subscale, Eating Attitudes Test (EAT) and EAT diet subscale, Eating Questionnaire-Revised (EQ-R), and the drive for thinness (EDI-DT), bulimia (EDI-B), body dissatisfaction (EDI-BD), ineffectiveness (EDI-I), perfectionism (EDI-P), interpersonal distrust (EDI-ID), interoceptive awareness (EDI-IA), and maturity fears (EDI-MF) scales of the Eating Disorders Inventory (EDI). Results of statistical analyses of psychological assessment measures are summarized in Table 4. Means and standard deviations as a function of disinhibition, restraint, and group are summarized in Tables 5 and 6.

Examination of group means for TFEQ-R and TFEQ-D scores indicated that the groups were indeed significantly different and extreme in terms of restraint and disinhibition scores. Out of a possible 16 items on the disinhibition scale, high disinhibition subjects (HD) received an average score of 14, while low disinhibition subjects (LD) received an average score of 3. Out of a possible 21 items on the restraint scale, high restraint subjects (HR) scored 16, while low restraint subjects (LR) scored 5. TFEQ-R and TFEQ-D scores were uncorrelated, $\underline{r} = -.10$, $\underline{p} > .05$. Weight and BMI were significantly correlated with TFEQ-D scores, $\underline{r} = 0.56$ and 0.58, respectively, $\underline{p} < .0001$, but uncorrelated with TFEQ-R scores, $\underline{r} = -0.14$ and -0.13 respectively, $\underline{p} > .05$. Correlations between restraint and disinhibition scores and psychological assessment measures are summarized in Table 7.

Table 4

ANOVA Results for Psychological Assessment Measures[a]

Variable	Disinhibition F	Disinhibition p	Restraint F	Restraint p	Disinhibition X Restraint F	Disinhibition X Restraint p
TFEQ-R	–	–	282.58	.0001	–	–
TFEQ-D	500.73	.0001	–	–	–	–
TFEQ-H	22.98	.0001	–	–	–	–
BULIT	66.02	.0001	–	–	–	–
BULIT-Binge	51.10	.0001	–	–	–	–
EAT	10.44	.002	38.03	.0001	–	–
EAT-Diet	8.59	.006	46.22	.0001	–	–
EQ-R	50.11	.0001	–	–	–	–
EDI-DT	30.73	.0001	40.04	.0001	–	–
EDI-B	92.49	.0001	–	–	–	–
EDI-BD	79.94	.0001	–	–	6.70	.01
EDI-I	25.75	.0001	–	–	–	–
EDI-P	9.77	.003	–	–	–	–
EDI-ID	–	–	–	–	–	–
EDI-IA	23.41	.0001	–	–	–	–
EDI-MF	–	–	–	–	–	–

[a]df = 1,40

Table 5

<u>Means and Standard Deviations for Psychological Assessment Measures as a Function of Disinhibition and Restraint</u>[a]

	Disinhibition		Restraint	
Variable	High	Low	High	Low
TFEQ-R	9.71	10.96	16.29[a]	4.96[b]
	(5.57)	(6.72)	(2.05)	(2.50)
EAT	23.95[a]	15.26[b]	28.14[a]	11.43[b]
	(14.81)	(9.44)	(11.98)	(7.52)
EAT-Diet	10.00[a]	5.61[b]	13.10[a]	2.78[b]
	(8.51)	(5.90)	(7.16)	(3.26)
EDI-DT	10.05[a]	3.43[b]	10.62[a]	2.91[b]
	(6.52)	(4.92)	(5.99)	(4.74)
TFEQ-D	14.10[a]	3.52[b]	8.67	8.48
	(1.45)	(1.62)	(5.44)	(5.78)
EQ-R	39.71[a]	25.43[b]	34.86	29.87
	(7.37)	(6.70)	(10.23)	(9.40)
TFEQ-H	9.57[a]	4.87[b]	7.19	7.04
	(3.08)	(3.35)	(3.80)	(4.20)
BULIT	84.19[a]	47.39[b]	68.10	62.09
	(18.16)	(11.36)	(23.63)	(24.06)
BULIT-Binge	36.71[a]	20.74[b]	28.14	28.57
	(9.24)	(4.84)	(10.47)	(11.34)
EDI-B	4.86[a]	0.13[b]	1.95	2.78
	(2.97)	(0.46)	(2.48)	(3.67)
EDI-BD	23.76[a]	8.00[b]	17.29	13.91
	(3.63)	(7.85)	(8.33)	(11.35)
EDI-I	4.29[a]	0.65[b]	2.52	2.26
	(5.15)	(1.61)	(4.66)	(3.67)
EDI-P	8.81[a]	5.22[b]	7.90	6.04
	(3.74)	(3.79)	(4.38)	(3.78)
EDI-IA	4.43[a]	0.96[b]	3.48	1.83
	(5.02)	(1.85)	(5.25)	(2.42)
EDI-MF	2.00	1.57	2.48	1.13
	(2.17)	(4.20)	(4.46)	(1.74)
EDI-ID	2.95	0.74	2.24	1.39
	(4.60)	(1.21)	(3.87)	(3.03)

[a]Means with different letters are significantly different (p<.01).

Table 6

Group Means and Standard Deviations for Psychological Assessment Measures[a]

Variable	Group: HR/HD	HR/LD	LR/LD	LR/HD
TFEQ-R	15.20	17.27	5.17	4.73
	(1.55)	(2.00)	(3.19)	(1.56)
EAT	33.60	23.18	8.00	15.18
	(14.16)	(7.05)	(3.59)	(8.99)
EAT-Diet	16.20	10.27	1.33	4.36
	(7.97)	(5.20)	(1.83)	(3.80)
EDI-DT	14.70	6.91	0.25	5.82
	(3.74)	(5.22)	(0.62)	(5.58)
TFEQ-D	14.00	3.82	3.25	14.18
	(1.56)	(1.66)	(1.60)	(1.40)
EQ-R	42.70	27.73	23.33	37.00
	(6.67)	(7.21)	(5.69)	(7.18)
TFEQ-H	8.80	5.73	4.08	10.27
	(3.08)	(3.93)	(2.64)	(3.04)
BULIT	85.70	52.09	43.08	82.82
	(21.87)	(9.70)	(11.41)	(14.99)
BULIT-Binge	35.20	21.73	19.83	38.09
	(10.73)	(4.54)	(5.11)	(7.93)
EDI-B	4.10	0.00	0.20	5.55
	(1.97)	(0.00)	(0.62)	(3.62)
EDI-BD	23.10[a]	12.00[b]	4.33[c]	24.36[a]
	(4.01)	(7.73)	(6.18)	(3.32)
EDI-I	5.00	0.27	1.00	3.64
	(5.91)	(0.65)	(2.13)	(4.54)
EDI-P	10.30	5.73	4.75	7.45
	(3.83)	(3.77)	(3.91)	(3.24)
EDI-IA	5.90	1.27	0.67	3.09
	(6.51)	(2.41)	(1.15)	(2.84)
EDI-MF	2.30	2.64	0.58	1.73
	(2.31)	(5.90)	(1.16)	(2.10)
EDI-ID	3.50	1.09	0.42	2.45
	(5.21)	(1.58)	(0.67)	(4.16)

[a]Means with different letters are significantly different ($p < .01$).

Table 7

Correlations of TFEQ-R and TFEQ-D Scores with Other Psychological Variables[a]

Variable	TFEQ-R	TFEQ-D
TFEQ-R	-	-0.10
EAT	0.59***	0.33
EAT-Diet	0.64***	0.31
EDI-DT	0.51**	0.49**
EQ-R	0.14	0.76***
TFEQ-D	-0.10	-
TFEQ-H	-0.03	0.64***
BULIT	0.05	0.79***
BULIT-Binge	-0.09	0.75***
EDI-B	-0.20	0.75***
EDI-BD	0.06	0.72***
EDI-I	-0.17	0.59***
EDI-P	0.13	0.45**
EDI-IA	-0.04	0.51**
EDI-MF	-0.00	0.30
EDI-ID	0.06	0.22

[a]** $p < .01$ *** $p < .0001$

Subjects' scores on the psychological assessment measures appeared to cluster as a function of dieting, overeating, weight, and psychological traits associated with eating disorders. As expected, significant main effects for restraint were found for scales measuring dieting behavior (i.e., EAT, EAT diet subscale, and EDI-drive for thinness subscale). HR subjects scored significantly higher on these measures than LR subjects did. Significantly more HR than LR subjects received EAT scores above 30, $\underline{X}^2$ (1) = 7.68, $\underline{p} < .006$. Eight subjects in the HR group (six in the HR/HD group and two in the HR/LD group), compared to one subject in the LR/HD group, scored in this range. Only the HR/HD group mean was above 30 on the EAT.

Also as expected, significant main effects for disinhibition were found for measures of overeating (i.e., BULIT, BULIT binge subscale, EQ-R, and EDI-bulimia subscale). HD subjects scored significantly higher on these scales than LD subjects did. Significantly more HD subjects (four in the HR/HD group, and three in the LR/HD group), compared to none in the LD groups, received scores above 88 on the BULIT, $\underline{X}^2$ (1) = 9.12, $\underline{p} < .003$. While HD subjects scored higher on the BULIT than LD subjects did, average BULIT scores for all groups were below the clinical range.

Significant main effects for disinhibition were also found for the TFEQ hunger subscale, EAT, EAT diet subscale, and EDI-drive for thinness subscale. HD subjects scored significantly higher on these scales than LD subjects did. Subjects' scores on the EAT were significantly correlated with BULIT scores, $\underline{r} = 0.60$, $\underline{p} < .0001$, and binge subscale scores, $\underline{r} = 0.55$, $\underline{p} < .0001$. Similarly, EAT diet subscale scores were significantly correlated with BULIT scores, $\underline{r}$ = 0.53, $\underline{p}$ < .0002, and binge subscale scores, $\underline{r}$ = 0.42, $\underline{p}$ < .004. EDI-DT scores were also significantly correlated with BULIT and BULIT binge subscale scores, $\underline{r}$ = 0.62 and 0.53, $\underline{p}$ < .0001 and .002, respectively.

Finally, significant main effects for disinhibition were found for the remaining subscales of the EDI, with the exception of the interpersonal distrust and maturity fears subscales. HD subjects scored significantly higher than did LD subjects on the psychological traits of body dissatisfaction, ineffectiveness, perfectionism, and interoceptive awareness. Analysis of scores on the body dissatisfaction subscale also yielded a significant interaction effect. HR/HD subjects were as dissatisfied with their body sizes as were LR/HD subjects, who weighed significantly more. These two groups were significantly more dissatisfied than HR/LD subjects were, who in turn, were significantly more dissatisfied with their body sizes than LR/LD subjects were.

While group means on most scales of the EDI were within normal limits, HR/HD subjects' scores on the drive for thinness, body dissatisfaction, and perfectionism subscales, and LR/HD subjects' scores on the body dissatisfaction subscale, were similar to scores obtained by clinical subjects. Overall results from subjects' EDI scores indicated that HD subjects tended to report a greater number of eating disorder symptoms, while HR subjects tended to report only symptoms related to weight concerns (i.e., drive for thinness and body dissatisfaction).

Weight History

Multiple 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) univariate analyses of variance were performed on weight history variables. Significance is reported at the .01 level. Weight history variables included highest nonpregnant weight, lowest adult weight, highest minus lowest weight (weight range), recent weight gain or loss, number of diets within the past year, and number of weight cycles of greater than ten pounds. Results of the statistical analyses are shown in Table 8. Means as a function of disinhibition, restraint, and group are summarized in Tables 9 and 10.

There were significant main effects for disinhibition for highest weight, lowest weight, weight range, recent weight loss, number of diets within the past year, and number of weight cycles of more than ten pounds. HD subjects reported significantly higher maximum weights, higher minimum adult weights, larger weight ranges, greater recent weight loss, more diets within the past year, and more weight cycles than LD subjects did.

Significant main effects for restraint were found for recent weight loss and number of diets within the past year. HR subjects reported larger recent weight losses and more diets within the past year than LR subjects did. Significant interaction effects were found for highest weight and weight range. HR/HD and LR/HD subjects reported higher maximum weights than the LD groups. Highest weight in HR/HD and HR/LD subjects did not differ. Highest weight in HR/LD and LR/LD subjects was lower and also did not differ. The range between LR/HD subjects highest and lowest weights (90 pounds) was

Table 8

ANOVA Results for Weight History Variables[a]

	Disinhibition		Restraint		Disinhibition X Restraint	
Variable	F	p	F	p	F	p
High Weight	20.49	.0001	-	-	8.59	.006
Low Weight	7.32	.01	-	-	-	-
Weight Range	21.35	.0001	-	-	7.29	.01
Weight Gain	-	-	-	-	-	-
Weight Loss	12.70	.001	10.97	.002	-	-
# Diets	41.51	.0001	13.74	.0006	-	-
# Wt. Cycles	39.72	.0001	-	-	-	-

[a]df = 1,40

Table 9

Means and Standard Deviations for Weight History Variables as a Function of Disinhibition and Restraint[a]

	Disinhibition		Restraint	
Variable[b]	High	Low	High	Low
High Weight	94.72[a] (30.05)	64.26[b] (14.71)	77.23 (17.00)	80.23 (35.11)
Low Weight	62.13[a] (2.11)	53.27[b] (9.54)	58.46 (10.72)	56.62 (12.54)
Weight Range	32.59[a] (21.92)	11.00[b] (7.88)	18.77 (9.51)	23.61 (25.25)
Weight Gain	2.00 (2.42)	0.89 (1.20)	1.66 (1.69)	1.23 (1.92)
Weight Loss	2.69[a] (2.86)	0.90[b] (2.50)	2.98[a] (4.15)	0.61[b] (1.21)
# Diets	4.20[a] (3.69)	0.95[b] (1.51)	3.65[a] (3.52)	1.50[b] (1.67)
# Wt. Cycles	7.89[a] (8.08)	1.26[b] (1.95)	4.93 (5.18)	4.21 (4.85)

[a]Means with different letters are significantly different ($p<.01$)

[b]All weight in kilograms

Table 10

Group Means and Standard Deviations for Weight History Variables[a]

Variable[b]	Group HR/HD	HR/LD	LR/LD	LR/HD
High Weight	82.69[ac] (14.89)	72.26[ab] (17.93)	56.92[b] (4.20)	105.65[c] (36.47)
Low Weight	59.34 (9.64)	57.65 (12.04)	49.24 (3.64)	64.66 (13.96)
Weight Range	23.35[a] (6.64)	14.61[a] (10.06)	7.68[a] (2.72)	40.99[b] (27.54)
Weight Gain	2.22 (1.89)	1.11 (1.50)	0.68 (0.90)	1.78 (2.95)
Weight Loss	4.32 (3.83)	1.65 (4.48)	0.15 (0.52)	1.07 (1.90)
# Diets	5.40 (4.03)	1.91 (3.02)	0.00 (0.00)	3.00 (3.35)
# Wt. Cycles	7.60 (7.07)	2.27 (3.29)	0.25 (0.62)	8.18 (9.09)

[a]Means with different letters are significantly different (p<.01)

[b]All weight in kilograms

significantly larger than the other groups. There were no differences between the groups in recent weight gain.

Group frequencies of self-reported positive personal and family history of obesity are shown in Table 11. The low frequencies of personal history of obesity in infancy and childhood prevented statistical analyses of these variables. When analyses were performed, significance is reported at the .01 level. Only one subject in the HR/LD group reported a history of obesity during infancy. Seven HD subjects, compared to three LD subjects, reported a history of obesity during childhood. Twelve HD subjects, compared to six LD subjects, reported a history of obesity during adolescence. Significantly more HD subjects (21) compared to LD subjects (7) reported obesity in adulthood, $\underline{X}^2$ (1) = 22.96, $\underline{p}$ < .0000. Seventeen HR subjects, compared to eleven LR subjects reported a personal history of obesity in adulthood. Finally, there were significant differences between the groups in terms of positive family history of obesity, $\underline{X}^2$ (1) = 8.78, $\underline{p}$ < .003. Significantly more HD subjects (20) than LD subjects (13) reported a positive family history of obesity.

<u>Body Composition and Resting Metabolic Rate</u>

These variables were considered to be of prime importance in the study. Therefore, a 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) multivariate analysis of variance, followed by univariate analyses, were performed. Because this procedure controls Type 1 error, significance is reported at the .05 level. Body composition variables included percent body fat as measured by

Table 11

Group Frequencies of Positive Personal and Family History of Obesity

	Group			
	HR/HD	HR/LD	LR/LD	LR/HD
Obesity	(N=10)	(N=11)	(N=12)	(N=11)
Personal History:				
Infancy(0-2yrs)	0	1	0	0
Childhood(2-12yrs)	3	3	0	4
Adolescence(13-20yrs)	6	5	1	6
Adulthood(over 20yrs)	10	7	0	11
Family History:	9	5	8	11

underwater weighing, bioelectrical impedance, and skinfold measurement, as well as weight of fat and fat-free body mass. The MANOVA yielded a significant main effect for disinhibition and a significant interaction effect. Results of the statistical analyses for body composition and RMR can be found in Table 12. Means as a function of disinhibition, restraint, and group are summarized in Tables 13 and 14.

Body Composition. Results of univariate analyses of body composition variables indicated significant main effects for disinhibition, as well as significant interaction effects, for estimates of percent body fat as assessed by underwater weighing,

Table 12

ANOVA Results for Body Composition and Resting Metabolic Rate[a]

	Disinhibition		Restraint		Disinhibition X Restraint	
Variable	*F*	*p*	*F*	*p*	*F*	*p*
MANOVA[b]	8.30	.0001	-	-	2.36	.05
% fat-UWW[c]	41.35	.0001	-	-	7.62	.009
% fat-BIA[d]	53.61	.0001	-	-	13.58	.0007
% fat-SF[ef]	41.75	.0001	-	-	4.21	.05
Fat (kg)	23.88	.0001	-	-	8.33	.006
FFM (kg)	13.48	.0007	-	-	6.28	.02
RMR[g]	18.37	.0001	-	-	4.55	.04
RMR/FFM[h]	7.65	.009	-	-	-	-

[a]df = 1,40

[b]df = 7,33

[c]Determined by underwater weighing

[d]Determined by bioelectrical impedance

[e]Determined by anthropometry (skinfold measurement)

[f]df = 1,39

[g]kcal/24hr

[h]kcal/kg FFM/24hr

Table 13

Means and Standard Deviations for Body Composition and Resting Metabolic Rate as a Function of Disinhibition and Restraint[a]

	Disinhibition		Restraint	
Variable	High	Low	High	Low
% fat-UWW[b]	42.42[a] (8.79)	27.47[b] (7.43)	33.52 (8.98)	35.60 (12.70)
% fat-BIA[c]	41.38[a] (9.52)	23.13[b] (8.73)	31.50 (9.56)	32.16 (15.53)
% fat-SF[d]	40.24[a] (4.27)	31.21[b] (5.04)	34.98 (6.04)	35.83 (7.04)
Fat (kg)	40.52[a] (23.39)	16.74[b] (8.28)	24.30 (10.80)	31.55 (26.75)
FFM (kg)	49.85[a] (9.53)	41.52[b] (5.43)	44.92 (6.47)	46.03 (10.39)
RMR[e]	1696[a] (410)	1294[b] (193)	1442 (247)	1525 (461)
RMR/FFM[f]	34.02[a] (3.97)	31.18[b] (2.61)	32.14 (3.35)	32.90 (3.82)

[a]Means with different letters are significantly different (p<.05)

[b]Determined by underwater weighing

[c]Determined by bioelectrical impedance

[d]Determined by anthropometry (skinfold measurement)

[e]kcal/24hr

[f]kcal/kg FFM/24hr

Table 14

Group Means and Standard Deviations for Body Composition and Resting Metabolic Rate[a]

Variable	HR/HD	HR/LD	LR/LD	LR/HD
	Group			
% fat-UWW[b]	37.90[a] (7.42)	29.54[b] (8.66)	25.58[b] (5.82)	46.54[c] (8.11)
% fat-BIA[c]	36.14[a] (7.39)	27.28[b] (9.62)	19.33[c] (5.93)	46.15[d] (8.92)
% fat-SF[d]	38.19[a] (5.00)	32.05[b] (5.54)	30.44[b] (4.64)	42.29[c] (2.04)
Fat (kg)	29.26[a] (9.32)	19.78[ab] (10.41)	13.94[b] (4.57)	50.76[c] (27.82)
FFM (kg)	46.26[a] (6.01)	43.70[ab] (6.91)	39.53[b] (2.53)	53.12[c] (11.16)
RMR[e]	1546[a] (237)	1384[ab] (226)	1244[b] (148)	1833[c] (493)
RMR/FFM[f]	33.47 (3.72)	30.93 (2.58)	31.41 (2.72)	34.52 (4.29)

[a]Means with different letters are significantly different ($p<.05$)

[b]Determined by underwater weighing

[c]Determined by bioelectrical impedance

[d]Determined by anthropometry (skinfold measurement)

[e]kcal/24hr

[f]kcal/kg FFM/24hr

bioelectrical impedance, and anthropometry. One subject in the LR/HD group was excluded from the analysis of skinfold measurements because her large size precluded obtaining an accurate estimate of her body composition. Results of the analyses indicated that LR/HD subjects had significantly higher percentages of body fat than the other groups did, as measured by all three procedures. With hydrostatic weighing and anthropometry, HR/HD subjects also had significantly higher percents of body fat than did HR/LD and LR/LD subjects who did not differ. When percent body fat was determined by bioelectrical impedance, HR/LD subjects had significantly higher percents of body fat than LR/LD subjects did. Examination of group means across procedures suggested that this latter difference may be related to the tendency of the Gray regression equation to underestimate body fat in younger, thinner individuals (i.e., LR/LD subjects). Based on the definition of obesity as 30% or greater body fat for females (Gray, 1989), the two HD groups would be classified as obese.

Estimates of percent body fat derived from the three methods for determining body composition were highly intercorrelated. Percent body fat as determined by underwater weighing was significantly correlated with BIA and anthropometry, $r = 0.94$ and 0.88 respectively, $p < .0001$. BIA was also significantly correlated with anthropometry, $r = 0.91$, $p < .0001$.

In addition to differing in relative percentage of fat tissue, subjects also differed in weight of fat and lean body tissue. Statistical analyses of both variables produced significant main effects for disinhibition and significant interaction effects. LR/HD subjects had significantly more fat tissue and more lean body tissue than the other groups. Fat mass and fat-free mass in HR/HD subjects were similar to those in HR/LD but significantly larger than those in LR/LD subjects. Fat and lean body mass did not differ in HR/LD and LR/LD subjects. A graphic representation of the relationship between body weight, fat mass, and fat-free mass is shown in Figure 3. Weight of fat and lean tissue were highly related, $\underline{r} = .83$, $\underline{p} < .0001$, and highly correlated with RMR, $\underline{r} = .88$, $\underline{p} < .0001$ for each variable.

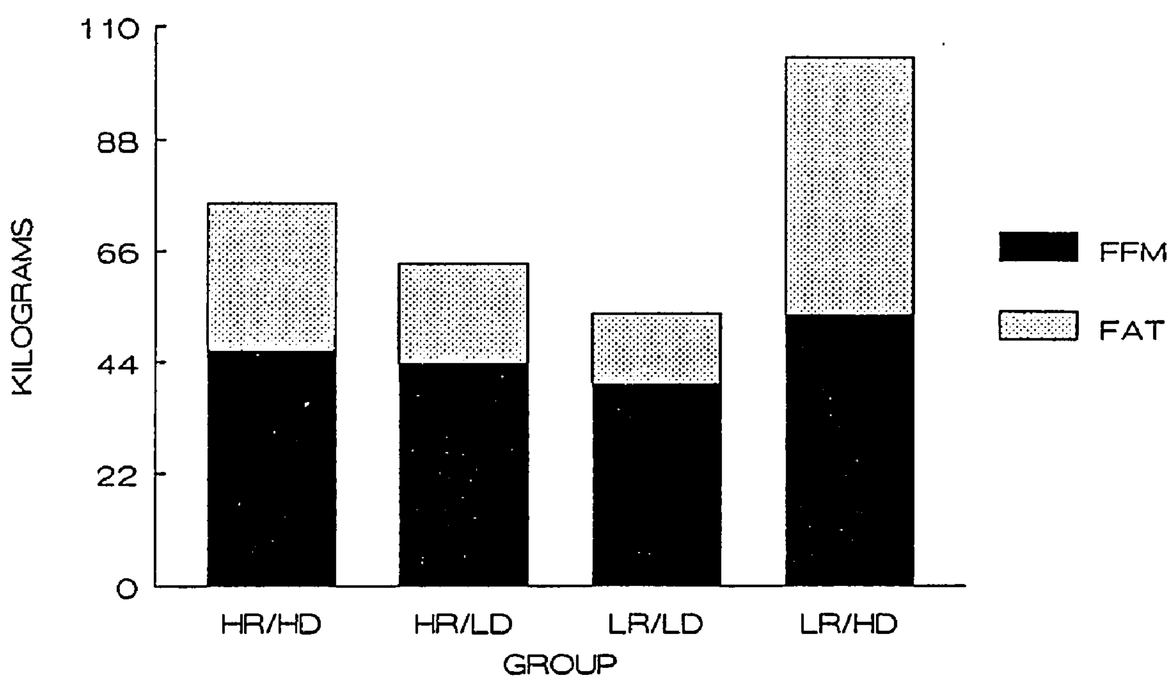

Figure 3. Mean body weight (kg), fat-free mass, and fat mass in four groups of women with high and/or levels of restraint and disinhibition.

Resting Metabolic Rate. Two forms of resting metabolic rate were examined: an absolute value (kcal/24hr) and RMR a function of fat-free body mass (kcal/kg FFM/24hr). As shown in Tables 12, 13, and 14, there was a strong main effect for disinhibition, and a weak interaction effect, when RMR was expressed in absolute values. RMR was significantly higher (by 400 kcal/24hr) in HD subjects than in LD subjects. LR/HD subjects had significantly higher RMRs than the other groups. RMR in HR/HD and HR/LD subjects was lower and did not differ. RMR in HR/LD subjects did not differ from LR/LD subjects who had the lowest RMRs. TFEQ-D scores were significantly correlated with RMR, $\underline{r} = .52$, $\underline{p} < .0003$, while TFEQ-R scores were uncorrelated with RMR, $\underline{r} = -0.11$, $\underline{p} > .05$. There were no differences across the groups in phase of the menstrual cycle in which RMR was measured, $\underline{F}\ (3,40) = 0.64$, $\underline{p} > .05$. Subjects in each group completed metabolic assessment between day 10 and day 14 of their cycles.

To determine if subject's current weight stability contributed to group differences in RMR, a 2 (Restraint: High and Low) X 2 (Disinhibition: High and Low) X 3 (Measurement: 1, 2, and 3) repeated measures ANOVA was performed. Results indicated a significant effect for measurement, $F\ (2,39) = 16.43$, $\underline{p} < .0001$, and a significant interaction between restraint and measurement, $\underline{F}\ (2,39) = 7.19$, $\underline{p} < .001$. Examination of the three mean weights as a function of restraint, found in Table 15, indicated that HR subjects lost an average of 0.2 kg during the first week, then gained an average of 1.0 kg during the second week, producing a net gain of 0.8 kg prior to measurement of resting metabolic rate. In contrast, LR subjects

Table 15

Means and Standard Deviations for Repeated Weight Measurement as a Function of Restraint

	Restraint	
Variable[a]	High	Low
Weight 1	68.41 (15.42)	77.30 (36.38)
Weight 2	68.21 (15.51)	77.43 (36.32)
Weight 3	69.21 (15.63)	77.58 (36.42)

[a]Weight in kilograms

continued to gain an average of 0.28 kg during the two weeks prior to metabolic testing. While these values may be statistically significant, this degree of weight fluctuation (i.e., less than two pounds) is considered normal. Overall results indicated that subjects' weights were quite stable before measurement of RMR and did not significantly influence findings.

When RMR was expressed in terms of fat-free body mass, a significant main effect for disinhibition was found. HD subjects had significantly higher RMRs than LD subjects did, even when their larger amount of lean tissue was taken into account. The interaction effect was not significant.

The groups differed significantly in amount of fat-free body mass. FFM was highly correlated with RMR. To statistically eliminate the effect of FFM on RMR, a 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) analysis of covariance was performed with fat-free mass as the covariate. The analysis yielded a significant effect for FFM, $\underline{F}$ (1,39) = 83.75, $\underline{p} < .0001$. The main effect for disinhibition was not significant, $\underline{F}$ (1,39) = 3.60, $\underline{p} > .05$. Similarly, subjects differed significantly in amount of fat tissue. Fat mass was also highly correlated with RMR. Therefore, an analysis of covariance, using fat mass as the covariate was performed to eliminate the effect of this variable on RMR. A significant effect for fat mass was found, $\underline{F}$ (1,39) = 70.84, $\underline{p} < .0001$. No other effects were significant.

Finally, RMR is known to decline with age. Although age was uncorrelated with RMR, $\underline{r} = 0.11$, $\underline{p} > .05$, there was considerable between and within group variability in terms of age. To adjust RMR for the effects of age, fat mass, and fat-free mass, an analysis of covariance was performed with these three variables as covariates. Results indicated significant effects for age, $\underline{F}$ (1,37) = 4.07, $\underline{p} < .05$, fat mass, $\underline{F}$ (1,37) = 15.93, $\underline{p} < .0003$, and fat-free mass, $\underline{F}$ (1,37) = 18.62, $\underline{p} < .0001$. The main effects for restraint and disinhibition, and the interaction effect, were not significant. Statistically controlling for these variables attenuated group differences in RMR. Adjusted group means and standard errors for RMR resulting from these analyses are shown in Table 16. Figure 4 depicts the relationship between unadjusted group means for RMR and group means for RMR adjusted for the effects of age, fat mass, and fat-free mass.

Table 16

Adjusted Group Means and Standard Errors for RMR[a] with Fat Mass, Fat-Free Mass, and Age as Covariates

	Group			
Covariate	HR/HD	HR/LD	LR/LD	LR/HD
Fat Mass	1528 ±58	1478 ±57	1464 ±59	1480 ±69
FFM	1520 ±55	1410 ±53	1449 ±55	1570 ±60
Age, FFM, & Fat Mass	1537 ±47	1456 ±46	1468 ±48	1489 ±55

[a]kcal/24hr

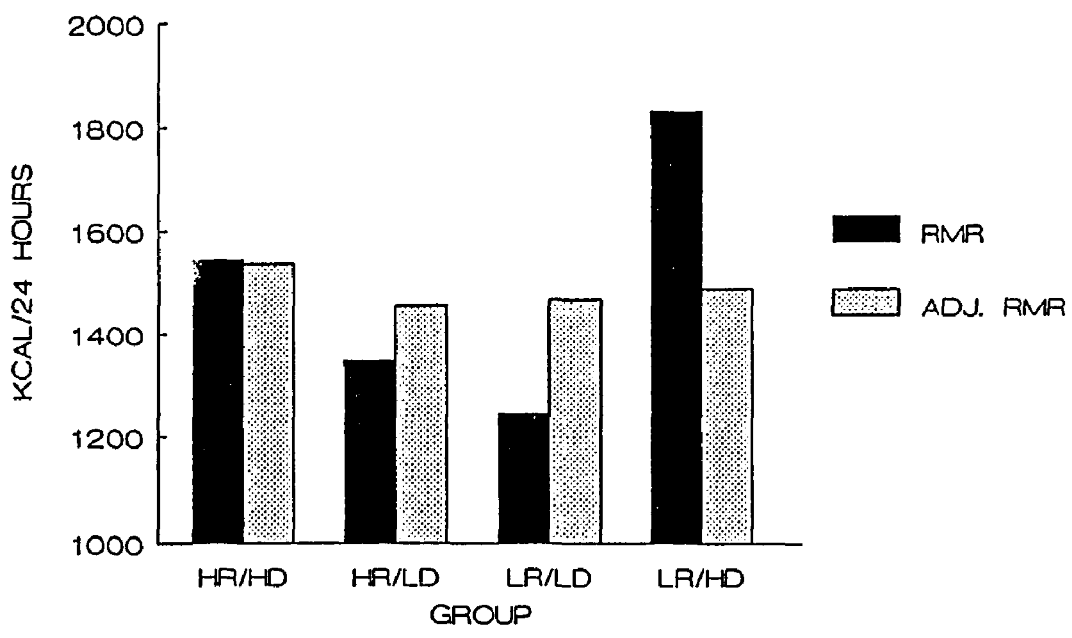

Figure 4. Mean resting metabolic rate (kcal/24hr), and mean resting metabolic rate adjusted for the effects of age, fat mass, and fat-free mass in four groups of women with high and/or low levels of restraint and disinhibition.

Energy Intake

A 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) multivariate analysis of variance, followed by univariate analyses, were performed on intake variables. Intake variables included average daily intake (kcal/24hr), number of meals and snacks recorded during the two-week period, number of self-reported undereating and overeating episodes during the period, ratio of three highest calorie to three lowest calorie days, and the percentages of caloric intake coming from fat, carbohydrates, and protein. Results are shown in Table 17. Means and standard deviations of intake variables as a function of disinhibition, restraint, and group are summarized in Tables 18 and 19.

Results of the multivariate analysis indicated a significant main effect for disinhibition. Univariate analyses yielded main effects for disinhibition for number of episodes of subjective overeating, and percent of intake from protein. HD subjects reported significantly more overeating episodes than LD subjects did. Percent of intake derived from protein for HD subjects was significantly higher than that for LD subjects. Significant main effects for restraint for percentage of fat and carbohydrates in the diet indicated that HR subjects derived less of their calories from fat, and more from carbohydrates, than LR subjects did. The significant interaction effect indicated that HR/LD subjects consumed a larger percent of carbohydrates than the other groups did. There were no significant differences between the groups in caloric intake, number of meals, number of snacks, self-reported undereating episodes, or the ratio of

Table 17

ANOVA Results for Energy Intake[a]

	Disinhibition		Restraint		Disinhibition X Restraint	
Variable	F	p	F	p	F	p
MANOVA[b]	2.59	.03	-	-	-	-
Kcal/24hr	-	-	-	-	-	-
# Meals	-	-	-	-	-	-
# Snacks	-	-	-	-	-	-
# Undereats	-	-	-	-	-	-
# Overeats	14.09	.0006	-	-	-	-
H/L Ratio[c]	-	-	-	-	-	-
Fat[d]	-	-	3.93	.05	-	-
Carbohydrate[d]	-	-	4.45	.04	4.05	.05
Protein[d]	5.49	.02	-	-	-	-

[a]df = 1,40

[b]df = 8,33

[c]Ratio of three highest to three lowest calorie days

[d]Percent of intake

Table 18

Means and Standard Deviations for Energy Intake as a Function of Disinhibition and Restraint[a]

	Disinhibition		Restraint	
Variable	High	Low	High	Low
Kcal/24hr	2043 (636)	1829 (501)	1805 (579)	2046 (555)
# Meals	36.76 (6.56)	35.96 (9.25)	35.95 (10.00)	36.70 (5.80)
# Snacks	32.67 (21.06)	35.09 (38.17)	41.71 (40.50)	26.83 (16.18)
# Undereats	13.29 (13.55)	10.83 (12.62)	12.86 (15.01)	11.22 (11.09)
# Overeats	18.62[a] (11.36)	7.26[b] (8.21)	11.57 (10.39)	13.70 (12.20)
H/L Ratio[b]	2.11 (0.49)	2.19 (0.58)	2.20 (0.58)	2.10 (0.50)
Fat[c]	35.95 (6.33)	33.39 (7.17)	32.52[a] (8.36)	36.52[b] (4.43)
Carbohydrate[c]	46.29 (7.61)	50.35 (8.66)	51.05[a] (10.87)	46.00[b] (3.97)
Protein[c]	17.62[a] (4.71)	15.04[b] (2.74)	17.00 (5.14)	15.61 (2.44)

[a]Means with different letters are significantly different ($p<.05$)

[b]Ratio of three highest to three lowest calorie days

[c]Percent of intake

Table 19

Group Means and Standard Deviations for Energy Intake[a]

Variable	Group HR/HD	HR/LD	LR/LD	LR/HD
Kcal/24hr	1783 (577)	1825 (608)	1832 (407)	2279 (617)
# Meals	36.30 (8.21)	35.64 (11.80)	36.25 (6.65)	37.18 (5.00)
# Snacks	36.00 (27.29)	46.91 (50.47)	24.25 (18.19)	29.64 (13.97)
# Undereats	16.80 (17.07)	9.27 (12.59)	12.25 (13.03)	10.09 (9.00)
# Overeats	15.80 (9.45)	7.73 (10.06)	6.83 (6.52)	21.18 (12.74)
H/L Ratio[b]	2.32 (0.57)	2.10 (0.59)	2.27 (0.58)	1.92 (0.33)
Fat[c]	34.20 (8.24)	31.00 (8.56)	35.58 (5.02)	37.55 (3.64)
Carbohydrate[c]	46.40[a] (10.51)	55.27[b] (9.79)	45.83[a] (4.06)	46.18[a] (4.05)
Protein[c]	19.20 (5.98)	15.00 (3.38)	15.08 (2.15)	16.18 (2.71)

[a]Means with different letters are significantly different ($p<.05$)

[b]Ratio of three highest to three lowest calorie days

[c]Percent of intake

the sum of calories from the three highest and the three lowest days during the two-week reporting period.

The substantial degree of variability in caloric intake both within individuals and within groups may have hindered finding significant group differences in caloric intake. Examination of group means in Table 19 indicated that LR/HD subjects consumed an average of 496 kcal/day more than HR/HD subjects did. While intake was lowest for HR/HD subjects, their intake was similar to that of the two LD groups. The range of intake between the HR/HD, HR/LD, and LR/LD groups was within 50 kcal. Caloric intake was not correlated with TFEQ-R and TFEQ-D scores, $\underline{r} = -.19$ and $.27$, respectively, $\underline{p} > .05$, but was significantly correlated with RMR, $\underline{r} = .49$, $\underline{p} < .0009$.

The groups differed significantly in weight. Fat mass and FFM were weakly correlated with intake, $\underline{r} = .30$ and $.35$, $\underline{p} < .05$ and $.02$, respectively. To determine if these variables had an effect caloric intake, an analysis of covariance with fat mass and FFM as covariates was performed. Results are shown in Figure 5. The effects for fat mass and FFM were not significant, nor were the effects for restraint or disinhibition. Covarying out these variables did little to alter the findings. The groups did not differ significantly in caloric intake.

Group means for number of subjects reporting an occurrence of daily intake below 800 kcal and above 2,500 kcal, and number days when intake was at these levels, are summarized in Table 20. There were no significant differences between the groups in the number of days when intake was below 800 kcal. Only 18% of the subjects ate less than 800

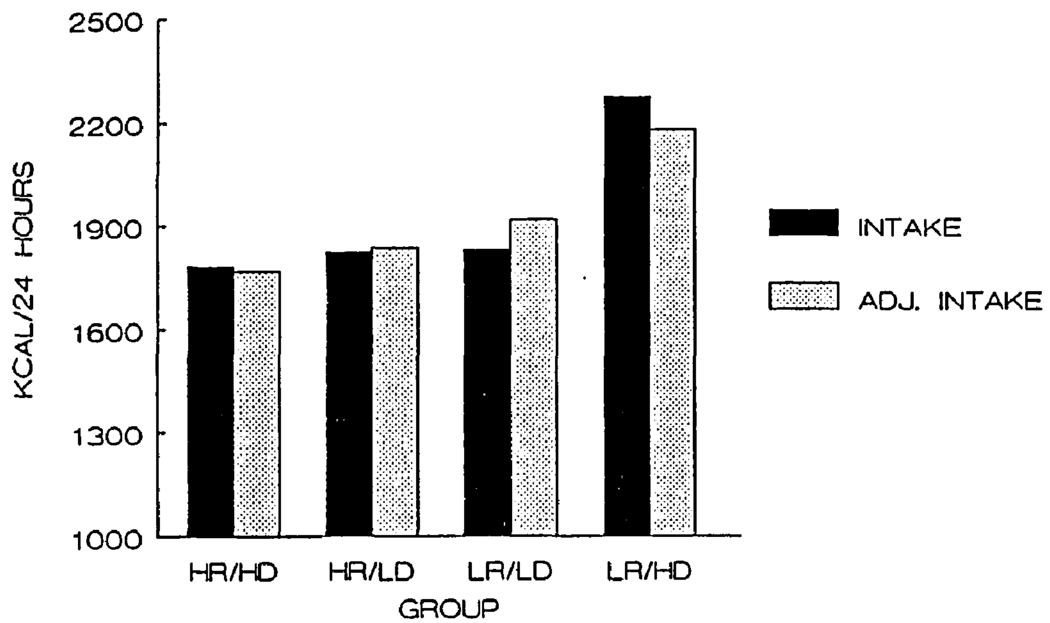

Figure 5. Mean energy intake (kcal/24hr), and mean energy intake adjusted for the effects of fat mass and fat-free mass, in four groups of women with high and/or low levels of restraint and disinhibition.

calories on at least one day. On the average, this level of intake occurred less than one day out of the 14 for all groups. In contrast, significantly more LR than HR subjects reported intake above 2,500 kcal, $\underline{X}^2$ (1) = 4.45, $\underline{p} < .04$. Ninety-one percent of LR/HD subjects and 67% of LR/LD subjects, compared to 50% of HR/HD subjects and 45% of HR/LD subjects, consumed more than 2,500 calories on at least one day. LR/HD subjects reported this level of intake 32% of the time while the other groups reported intake in excess of 2,500 calories 14% of the time. This difference was not significant. Frequency of self-reported binging was very low. Only two subjects in the HR/HD group, two subjects in the LR/HD group, and one subject in the HR/LD group reported binges.

Table 20

Number of Subjects and Average Number of Days When Daily Intake Was Below 800 kcal and Above 2500 kcal

	Group			
	HR/HD	HR/LD	LR/LD	LR/HD
Variable	(N=10)	(N=11)	(N=12)	(N=11)
Number of Subjects:				
Intake <800 kcal	2	3	2	1
Intake >2500 kcal	5	5	8	10
Number of Days:[a]				
Intake <800 kcal	0.80	0.82	0.18	0.80
Intake >2500 kcal	1.70	2.45	1.92	4.45

[a]Out of 14 days

Energy Expenditure

A 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) multivariate analysis of variance was performed on expenditure variables. Variables included in the analysis were estimates of energy expenditure in two forms: absolute values (kcal/24hr) and a function of body weight (kcal/kg/24hr). These estimates were derived from two sources: an objective measure (Caltrac Activity Meter) and a subjective measure (Activity Record). The MANOVA yielded a significant main effect for disinhibition. The restraint and interaction effects approached significance. The results are shown in Table 21. Means as a function of disinhibition, restraint, and group are summarized in Tables 22 and 23.

Results of univariate analyses indicated a significant main effect for disinhibition with the objective and subjective measures of when expenditure was expressed in absolute values. Data from the Caltrac indicated that HD subjects expended significantly more calories (608 kcal/24 hours) than LD subjects did. The interaction effect was also significant. Expenditure was greatest in LR/HD and HR/HD subjects. Expenditure in HR/HD and HR/LD subjects was similar. Expenditure was lowest in LR/LD subjects, and substantially lower than expenditure in the HD groups, but similar to that in the HR/LD group. When subjective estimates of energy expenditure derived from the activity record were examined, HD subjects reported significantly higher energy expenditure than LD subjects did (1165 kcal/24 hours).

When energy expenditure was examined as a function of body weight, a significant main effect for disinhibition was found with the Caltrac measure. However, the effect was reversed. HD subjects expended significantly less energy (3 kcal/kg/24 hours) than LD subjects did when their larger body sizes were taken into account. When body weight was taken into account for subjective ratings of activity, a significant effect for restraint emerged. HR subjects reported greater energy expenditure (4 kcal/kg/24 hours) than LR subjects did.

Subjective and objective estimates of energy expenditure were highly correlated, $\underline{r} = .90$, $\underline{p} < .0001$, when absolute kcal expenditure

Table 21

ANOVA Results for Energy Expenditure[a]

	Disinhibition		Restraint		Disinhibition X Restraint	
Variable	F	p	F	p	F	p
MANOVA[b]	7.54	.0002	2.26	.08	2.52	.06
Caltrac[ce]	19.63	.0001	-	-	6.19	.02
Act. Record[de]	16.64	.0002	-	-	-	-
Caltrac/Wt[cf]	4.51	.04	-	-	-	-
Act. Rec./Wt[df]	-	-	7.13	.01	-	-

[a]df = 1,40

[b]df = 4,37

[c]Caltrac Activity Meter

[d]Activity Record

[e]kcal/24hr

[f]kcal/kg/24hr

Table 22

Means and Standard Deviations for Energy Expenditure as a Function of Disinhibition and Restraint[a]

	Disinhibition		Restraint	
Variable	High	Low	High	Low
Caltrac[bd]	2244[a] (588)	1636[b] (312)	1911 (394)	1941 (675)
Act. Record[cd]	3365[a] (1194)	2200[b] (636)	2752 (836)	2759 (1320)
Catlrac/Wt[be]	25.95[a] (5.23)	28.58[b] (2.77)	28.49 (4.39)	26.27 (4.00)
Act. Rec./Wt[ce]	37.79 (5.93)	38.04 (5.20)	40.05[a] (4.79)	35.97[b] (5.46)

[a]Means with different letters are significantly different ($p<.05$)

[b]Caltrac Activity Meter

[c]Activity Record

[d]kcal/24hr

[e]kcal/kg/24hr

Table 23

Group Means and Standard Deviations for Energy Expenditure[a]

	Group			
Variable	HR/HD	HR/LD	LR/LD	LR/HD
Caltrac[bd]	2048[ab] (406)	1788[bc] (355)	1498[c] (191)	2424[a] (685)
Act. Record[cd]	3067 (800)	2466 (796)	1956 (313)	3636 (1451)
Caltrac/Wt[be]	27.86 (5.57)	29.06 (3.16)	28.15 (2.42)	24.21 (4.45)
Act. Rec./Wt[ce]	41.03 (5.64)	39.16 (3.93)	37.01 (6.14)	34.84 (4.63)

[a]Means with different letters are significantly different ($p<.05$)

[b]Caltrac Activity Meter

[c]Activity Record

[d]kcal/24hr

[e]kcal/kg/24hr

was examined. This correlation was attenuated when values were expressed as a function of body weight, $r = .36$, $p < .02$. A consistent pattern with all estimates of energy expenditure was that subjective ratings were higher than objective values by an average of 42% (range 31 to 50%). A graphic representation of subject's energy expenditure in absolute values, and as a function of body weight, is shown in Figures 6 and 7.

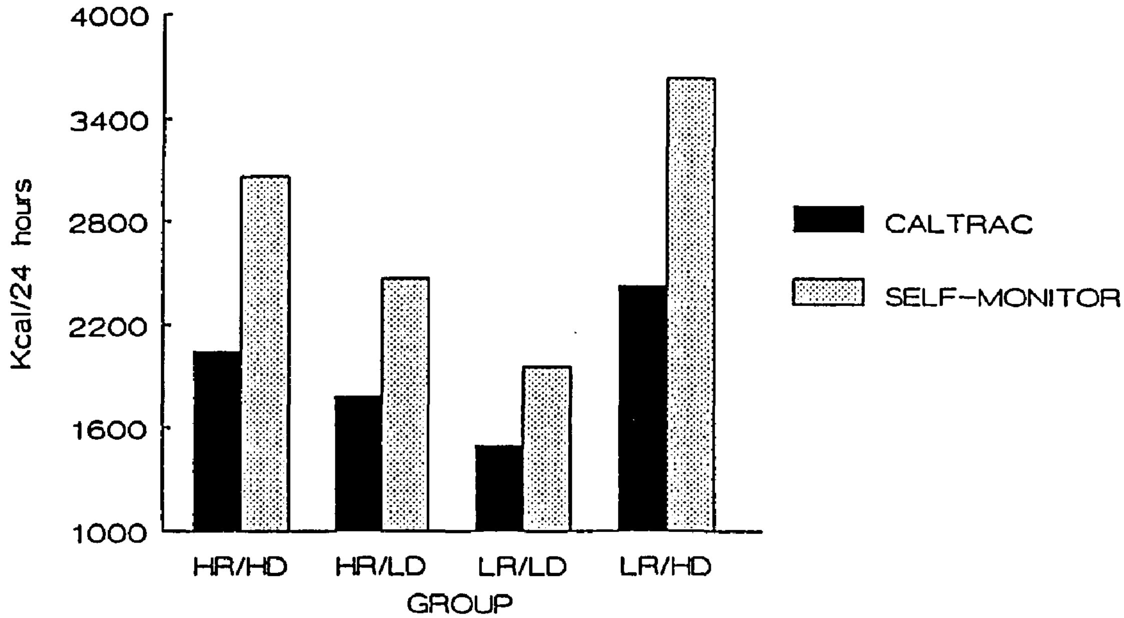

Figure 6. Mean energy expenditure (kcal/24hr) as estimated from the Caltrac Activity Meter and Activity Record in four groups of women with high and/or low levels of restraint and disinhibition.

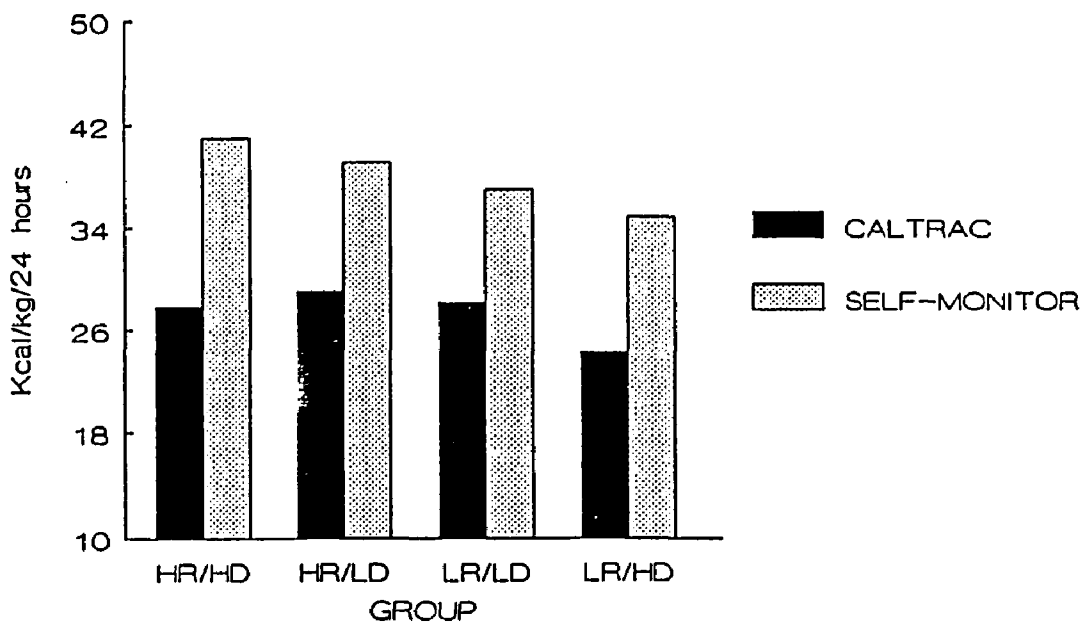

Figure 7. Mean energy expenditure as a function of body weight as estimated from the Caltrac Activity Meter and Activity Record in four groups of women with high and/or low levels of restraint and disinhibition.

Subject's weight was used to calculate energy expenditure for the Caltrac and activity record. Weight was highly correlated with these variables, $r = .89$ and $.93$, $p < .0001$ for the Caltrac and activity record, respectively. There were large group differences in weight and body composition. To statistically control for the effects of both components of body weight on energy expenditure, a 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) analysis of covariance was performed on absolute expenditure as measured by the Caltrac, using fat mass and FFM as covariates. Results indicated significant effects for fat mass, $F\ (5,38) = 11.48$, $p < .002$, and FFM, $F\ (5,38) = 11.63$, $p < .002$. No other effects were significant. Controlling for body composition eliminated differences in energy expenditure between the groups. A graphic representation of unadjusted and adjusted group means for energy expenditure as estimated from Caltrac data is shown in Figure 8.

Energy Balance

To validate that subjects were in energy balance, as demonstrated by their weight stability during the two weeks prior to metabolic assessment, subject's average daily intake was subtracted from their average daily expenditure as measured by the Caltrac. A 2 (Disinhibition: High and Low) X 2 (Restraint: High and Low) ANOVA was performed. Results showed a weak effect for disinhibition, $F\ (1,40) = 5.06$, $p < .03$. HD subjects were in negative energy balance (by 202 kcal/24hr), while LD subjects were in positive energy balance (by 192 kcal/24hr). A graphic presentation of the relationship between intake and expenditure across the groups is shown in Figure 9. Findings

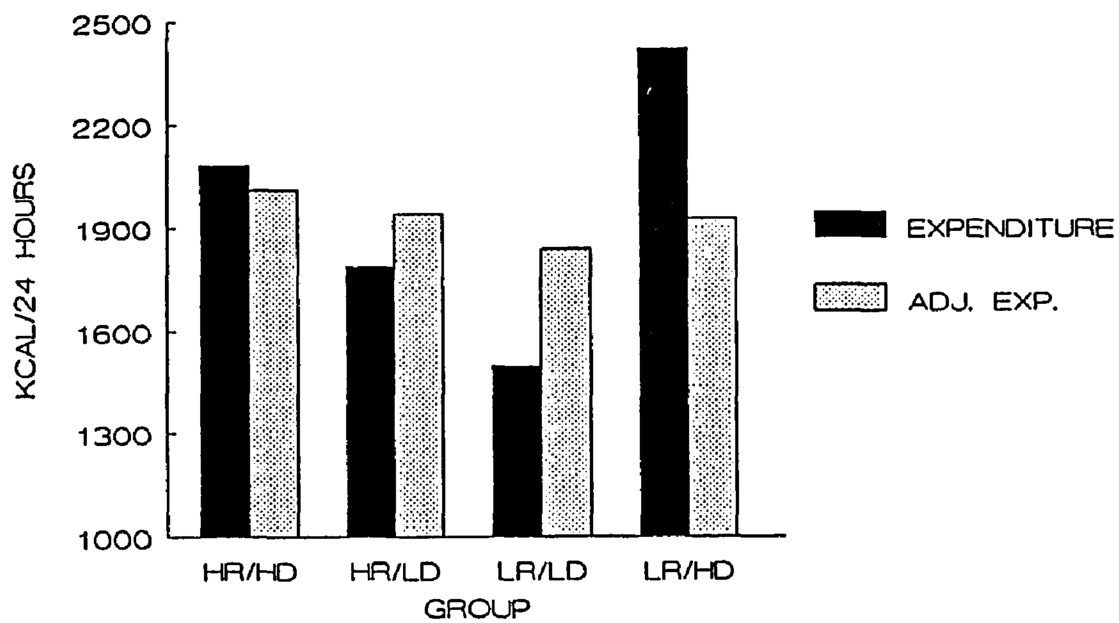

Figure 8. Mean energy expenditure (kcal/24hr) as estimated from the Caltrac Activity Meter, and mean energy expenditure adjusted for the effects of fat mass and fat-free body mass, in four groups of women with high and/or low levels of restraint and disinhibition.

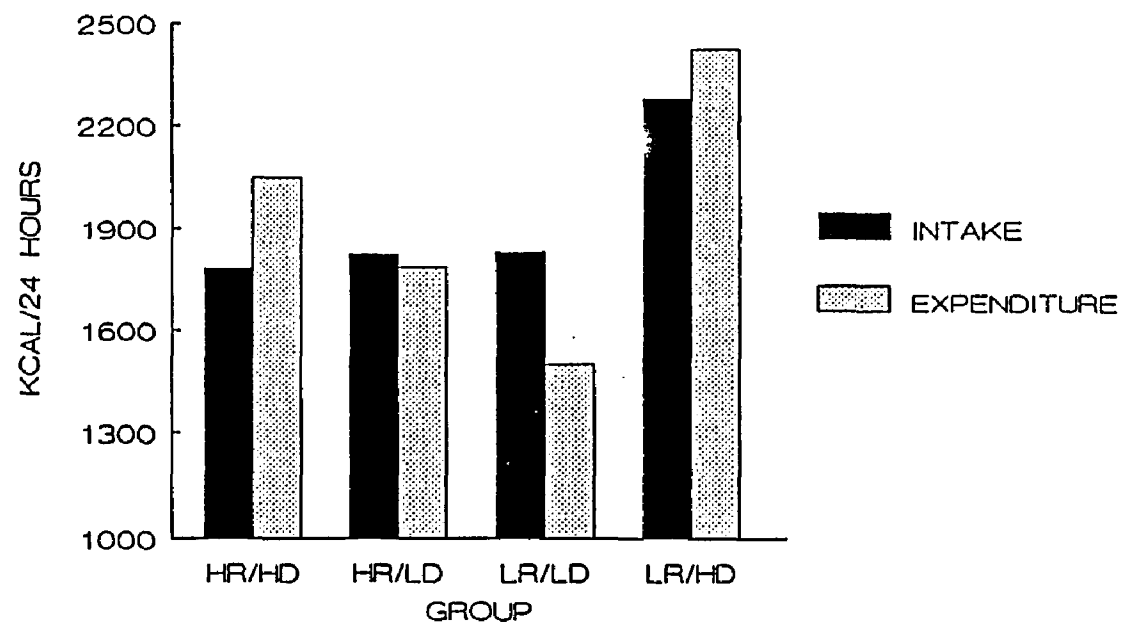

Figure 9. Differences between mean daily intake and expenditure (kcal/24hr) in four groups of women with high and/or low levels of restraint and disinhibition.

indicated that excesses or deficits for all groups were less than 350 kcal/24hr. These values translate into less than a one and a half pound loss or gain for all groups over a two-week period. The data were consistent with subjects' small weight changes during the study and confirmed that subjects were in energy balance before measurement of RMR.

Discussion

Resting Metabolic Rate and Body Composition

The main objective of the study was to examine differences is resting metabolic rate in female subjects who differed in degree of control and loss of control over their eating. The major finding of the study was that disinhibition, loss of control, was the predominant variable affecting resting metabolic rate in female subjects of varying ages and weights. Level of restraint had no effect on RMR values. When RMR was expressed in absolute values, women who were unable to control their eating and overate recurrently (LR/HD subjects) had significantly higher RMRs (1833 kcal/24hr) than the other groups. Women who alternated between periods of control and loss of control of their eating (HR/HD subjects) had significantly higher RMRs (1546 kcal/24hr) than women who did not attempt to control their eating had (LR/LD subjects, 1244 kcal/24hr). RMRs for women who consistently controlled their eating without overeating (HR/LD subjects, 1384 kcal/24hr) did not differ significantly from women who intermittently lost control, or from women who did not attempt to control their eating. Twenty-seven percent of the variance in RMR was accounted for by TFEQ-D scores. Level of restraint had no effect on RMR. TFEQ-R scores accounted for only 1% of the variance in RMR.

Findings could not be explained by uncontrolled variables such as smoking, caffeine consumption, or phase of the menstrual cycle. The five subjects who smoked were evenly distributed across the groups. Caffeine consumption was under 300 mg/day for all groups. This amount is equivalent to approximately three cups of coffee. For all groups, RMR was measured during the post-menstrual or follicular phase of the cycle when RMR is lowest.

While group differences in RMR could not be explained by the uncontrolled variables above, the uncontrolled variable of weight was strongly associated with group membership and RMR. In fact, when group differences in weight were controlled, differences in RMR across the groups disappeared.

There was substantial variation in weight, body mass index, and body composition across the groups. Although subjects were weight-stable before measurement of RMR, subjects who overate recurrently without periods of restriction weighed significantly more (Mean = 228 pounds), and had significantly higher BMIs (Mean = 35.45), than other subjects did. Body weight did not differ between women who intermittently restricted intake between episodes of overeating (Mean weight = 164 pounds), women who consistently controlled their eating (Mean weight = 138 pounds), and women who did not restrict or overeat (Mean weight = 117 pounds). In contrast, BMI was similar in women who alternated between control and loss of control over their eating and women who consistently controlled their eating (Mean BMI = 27.88 and 23.13, respectively), and was significantly higher than BMI in women who did not attempt to control their eating (Mean BMI = 19.07). In women who lost control of their eating, it appeared that restraint tended to attenuate body size. In women who did not lose control of their eating, restraint had the opposite effect and resulted in a larger body size for women who attempted to control their eating. The pattern of results for BMI is consistent with the findings reported by Westenhoefer and Pudel (1989, cited in Westenhoefer, Pudel, & Maus, 1990). BMI was highest in women who were unable to control their eating (LR/HD), lowest in women who did not attempt control (LR/LD), and intermediate in the two groups of women who attempted control over their eating (HR/HD and HR/LD).

Body size and composition, particularly fat-free body mass, have been shown to be the most important determinant of RMR (Foster et al., 1988; Heshka et al., 1990; Ravussin et al., 1986). In the present study, groups differed significantly in fat-free mass, fat mass, and percent body fat. Women who were unable to control their eating had significantly higher FFM (53 kg), fat mass (51 kg), and percent body fat (47%), than the other groups. FFM (46 kg), fat mass (29 kg), and percent fat (38%) in women who alternated between control and loss of control over eating were significantly higher than FFM (40 kg), fat mass (14 kg), and percent fat (26%) in women who did not attempt to control their eating. Women who consistently controlled their eating had intermediate, but not significantly different, FFM (42 kg) and fat mass (20 kg) compared to women who intermittently lost control and women who did not attempt control of their eating. Percent body fat of women who consistently controlled their eating (30%) was significantly lower than that of women who intermittently lost control, but did not differ from that of women who did not attempt to control their eating.

Accepted indices of obesity for women include a BMI greater than 27 and percent body fat greater than 30% (Gray, 1989; Obesity & Health, January/February 1991). A BMI of 22 is considered an index of ideal body weight (Tokunaga et al., 1990). Based on both criteria, women who overate (HR/HD and LR/HD) were obese. Women who consistently controlled their eating (HR/LD) were slightly above ideal weight. Normal eaters who did not attempt to control their eating (LR/LD) were slightly below normal weight. Consistent with previous findings (Laessle et al., 1989b; Tuschl et al., 1990), women who controlled their eating tended to be heavier than women who did not. Present results demonstrated that high levels of cognitive restraint do not necessarily result in lower weight levels. The findings question the success and validity of a conscious intention to restrict intake for weight control and suggest that intent does not necessarily imply success.

Data from the three methods used to determine body composition indicated a very high level of agreement between the procedures. This finding is in contrast to the those of Devlin et al. (1990) who found discrepancies between estimates of body composition with anthropometry, hydrostatic weighing, and bioelectrical impedance. The failure of Devlin and his colleagues to find differences in RMR when FFM was determined by anthropometry and hydrostatic weighing may have been due to the restricted range of fat and FFM in their normal-weight subjects. The restricted range of values may have produced low correlations between methods and prevented finding significant differences with the three procedures. In the present study, the range of fat and FFM was quite large across groups and resulted in high correlations between methods (.88 to .94).

In the present study, the pattern of results was identical when body composition was determined by underwater weighing and anthropometry. Women who were unable to control their eating had a significantly higher percent body fat than did women who were able to gain intermittent control. Percent body fat of women who consistently controlled their eating, and of women who did not attempt control, were similar and significantly lower than those of women who lost control of their eating. When percent fat was determined by bioelectrical impedance, women who did not attempt to control their eating had a significantly lower percent body fat than the other groups did. This finding can be explained by the fact that the prediction equation used tended to underestimate body fat in younger, thinner women. This conclusion emphasizes the importance of developing regression equations for bioelectrical impedance for the population under investigation.

When RMR was expressed as a function of metabolically active fat-free body mass, subjects who overate had significantly higher RMRs than did subjects who did not overeat. This finding was likely a function of their substantially larger fat mass (112 and 64 pounds in the LR/HD and HR/HD groups, respectively). While fat tissue is considered relatively inert, the large amount of fat tissue in these subjects suggested that this factor must have contributed to resting metabolism to some degree. This finding is consistent with previous reports of metabolic differences between subjects with significantly different fat masses (Weststrate et al., 1990). In the present study, FFM and fat mass were very highly correlated with RMR. When each of these variables was statistically controlled, group differences in RMR disappeared. This finding was consistent with previous research examining RMR in lean and morbidly obese subjects (Prentice et al., 1986; Ravussin et al., 1982; Weststrate et al., 1990). The range of RMR values across the groups decreased from 589 to 160 kcal/24hr when the effect of FFM was removed, and from 589 to 64 kcal/24hr when the effect of fat mass was removed, indicating that fat mass substantially contributed to group differences in RMR. While RMR was not correlated with age in this study, RMR has been shown to decrease with age. When age was added as a covariate, the variable's effect was minimally significant, suggesting that age did not contribute substantially to differences in RMR compared to the contributions of fat and fat-free body mass.

The failure of the study to find differences in adjusted RMR in terms of restraint was unexpected. This study was the first to examine the effect of restraint on RMR in obese subjects. The inconsistency of current results with previous findings of lower RMRs in high restraint subjects may have been related to the heterogeneity of weight and body composition across groups in the present study. The only other study examining energy expenditure in restrained normal women used younger normal-weight subjects. Subjects in the Tuschl et al. (1990) study were between the ages of 18 and 30. Average weight and BMI for high restraint and low restraint subjects were 58 kg and 21, and 57 kg and 20, respectively. Both groups were 28% body fat. Studies examining RMR in bulimic women also utilized younger, normal-weight subjects (Bennett et al., 1989; Devlin et al., 1990). In contrast, the majority of subjects in the present study were substantially older (Mean = 34 yrs) and heavier (Mean weight = 74 kg) than those in previous reports. Current findings suggest that extreme caution must be used in generalizing results of studies of normal-weight subjects to obese populations. The two populations differ significantly in body size and composition. These biological differences are likely to be related to psychological and behavioral differences also. As the present study demonstrated, body weight was highly related to loss of control over eating (disinhibition) but not to control over eating (restraint), suggesting that the relationship between restraint and disinhibition may be different in normal-weight and obese individuals.

Weight History

The present study also examined several weight history variables to replicate and expand findings from previous studies of restrained eaters. Current results indicated that subjects who lost control of their eating reported significantly higher maximum weights (208 vs 141 pounds), higher minimum weights (137 vs 117 pounds), larger weight ranges (72 vs 24 pounds), and larger recent weight losses (6 vs 2 pounds) than did subjects who did not overeat. Subjects who controlled their eating also reported larger recent weight losses (6.5 vs 1.5 pounds) than did subjects who did not diet. Interestingly, the amount of recent weight loss was similar in women who controlled their eating and women who were unable to do so. Furthermore, recent weight gain was not substantially different across the groups. All groups gained between 1.5 and 5 pounds within the few months prior to the study. The large differences between highest and lowest weights in HD subjects may have been a reflection of their overall higher weight levels.

Twenty-eight of the 44 subjects reported a personal history of obesity. By adulthood, all 21 subjects who were unable to control their eating, even to some degree, were obese. Seven of the 11 subjects who constantly controlled their eating reported having been obese at some time during adulthood. In contrast, none of the subjects who did not attempt to control their eating reported having been obese in adulthood. As age increased, a larger number of subjects reported personal histories of obesity. This finding suggests that once obesity develops, it may be quite difficult to modify, possibly because of the development of dysfunctional eating patterns. All eleven subjects who were unable to control their eating reported a family history of obesity. Nine of the subjects who alternated between control and loss of control, eight of the subjects who did not attempt control, and five of the subjects who constantly maintained control, reported a family history of obesity. While genetic factors may have played a part in the development of subjects' obesity, this factor cannot explain why 67% of the normal-weight subjects who did not attempt to control their eating had positive family histories of obesity. Other behavioral or physiological factors must have contributed to the absence of obesity in these subjects. One potential contributing factor may be a regulated eating pattern.

Findings relating to subject's weight history further suggested that women who did not control their eating, whether or not they attempted to, experienced substantial weight fluctuations. These subjects also reported long-term personal histories of obesity and a family history of obesity. However, family history of obesity was not unique to obese subjects.

Current findings were not consistent with previous reports of higher maximum weights in restrained subjects (Devlin et al., 1990; Laessle et al., 1989b; Lowe, 1984; Tuschl et al., 1990). However, only one study (Laessle et al., 1989b) reported subjects' TFEQ-D scores. High restraint normal-weight subjects had low disinhibition scores in this study. The discrepancy of this finding with current results may be related to the strong relationship between disinhibition and weight in the present study, and the absence of a relationship between restraint and weight. Perhaps previous or current weight may have a strong influence on level of restraint which may overshadow restraint in some cases.

Correlates of Disinhibition and Restraint

Psychological Measures. This study was the first to examine the combination and individual contributions of restraint and disinhibition. Findings demonstrated the importance of examining these two independent dimensions of eating behavior.

Examination of group differences on psychological measures argued for the construct validity of the restraint and disinhibition scales of the TFEQ. Results of psychological assessment indicated that the groups appeared to fit the desired categories in terms of their self-reported eating behavior. As expected, subjects who controlled their eating (HR) scored significantly higher on measures of dieting behavior (EAT, EAT diet subscale, and EDI-drive for thinness subscale) than did subjects who did not control their eating (LR). Similarly, subjects who were unable to control their eating (HD) scored significantly higher on measures of overeating or binge eating (BULIT, BULIT binge subscale, EDI-bulimia subscale, and EQ-R) than did subjects who did not lose control of their eating (LD). Results further indicated that subjects who overate also scored significantly higher on measures of dieting behavior than did subjects who did not overeat. This finding is consistent with the proposed relationship between dieting and binge eating (Polivy & Herman, 1985,) and with the speculation that restraint is a necessary but insufficient condition for the development of disordered eating behavior (Tuschl et al., 1990; Westenhoefer et al., 1990).

Women who lost control of their eating reported experiencing a larger number of eating disorder symptoms, including drive for thinness, bulimic tendencies, body size dissatisfaction, feelings of ineffectiveness, perfectionistic tendencies, poor interoceptive awareness, and higher levels of perceived hunger than women who maintained control over eating did. In contrast, women who controlled their eating reported experiencing only symptoms related to weight concerns, such as drive for thinness and body dissatisfaction. Women who alternated between control and loss of control weighed substantially less than women who were unable to control their eating did (228 versus 164 pounds, respectively). However, these women reported equivalent levels of body size dissatisfaction. This finding may be related to the frustration which arises from the losing battle of weight cycling in women who vacillate between control and loss of control. In support of this speculation, current results indicated that women who alternated between control and loss of control reported a similar number of weight cycles as did women who did not control their eating.

Current findings further demonstrated the importance of independently examining loss of control over eating when looking at dieting behavior. In studies reporting differing levels of psychopathology in normal-weight bulimic, restrained, and unrestrained subjects (Laessle et al., 1989; Rossitier et al., 1989), high restraint bulimic and normal subjects also had significantly higher levels of disinhibition than unrestrained subjects had. In light of present findings, failure to discriminate between the two components of eating behavior renders the conclusions of these studies uncertain. In the present study, women with high levels of disinhibition, even without high restraint (LR/HD subjects), reported substantially more eating disorder symptoms than did high restraint or weight-preoccupied subjects (HR/LD subjects). This finding is inconsistent with previous reports of increased psychopathology in normal-weight, weight-preoccupied women (Garner et al., 1983; Garner et al., 1984). However, when loss of control over eating, and therefore weight, are considered, the contribution of restraint is minimal and loss of control over eating appears to be the predominant factor involved in the development of psychological traits associated with eating disorders.

The low incidence of eating disorders in the current sample (7%), suggested that extreme scores on the restraint and disinhibition scales of the TFEQ were unable to adequately discriminate normal from disordered eating. Subjects' scores were above the 70^{th} percentile on each scale. Even at these extreme levels, eating disorders were infrequent and eating disorder symptoms were not in the clinical range. Therefore, caution should be used when generalizing the findings of the present study to eating disordered populations.

Behavioral Measures: Energy Intake. Self-reported average daily caloric intake of women who lost control over their eating did not differ from intake of women who did not lose control. Similarly, intake of women who maintained restrictive control did not differ from that of women who did not attempt to control their eating. Average intake ranged from 1800 to 2300 kcal/day. In addition, highest reported intake in all groups was about twice as great as lowest intake, suggesting that eating was not differentially chaotic across the groups. When the effects of weight and body composition were controlled, there were no differences between the groups in energy intake.

While current results were consistent with Westenhoefer and his colleagues'(1990) finding of highest intake in women who were unable to control their eating (LR/HD), they were not consistent with previous reports that intake was lowest in women who consistently controlled their eating (Laessle et al., 1989b; Tuschl et al., 1990; Westenhoefer et al., 1990). While not statistically different from the other three groups, current results indicated that intake was lowest in women who alternated between control and loss of control over their eating (1783 kcal/24hr). All groups consumed at or below the RDA of 2,200 calories for women in their age range (National Research Council, 1989). Intake findings further supported the speculation that intended restraint does not necessarily imply success in caloric restriction.

Several important factors must be considered when interpreting results related to energy intake. First, subjects were quite heterogeneous in terms of their eating behavior. There was a great deal of variability within individuals and within groups in caloric intake. This finding is consistent with previous reports of large variability in intake for restrained eaters (Laessle et al., 1989b; Tuschl et al., 1990) and extends the finding to disinhibited eaters. The large variance may have precluded finding statistically significant differences between the groups in energy intake.

Second, the overriding effect of disinhibition, and its high correlation with weight, may have masked any group differences associated with restraint. Consistent with this speculation, women who alternated between control and loss of control of their eating reported the lowest caloric intake.

Finally, the ubiquitous problem of reliance on self-report must always be considered when interpreting data from food records. Although subjects were well-trained and monitored in accurate food weighing and measurement, recent evidence suggests that even well-motivated and trained subjects tend to substantially underreport intake by an average of 18% (Lissner, Habicht, Strupp, Levitsky, Haas, & Roe, 1989; Mertz et al., 1991; Prentice et al., 1986). In addition, underreporting may have been more pronounced in heavier subjects. There is some evidence to suggest that such a bias toward underreporting by obese subjects exists (Prentice et al., 1986). In support of this speculation, energy intake of heavier subjects was similar to that of subjects who weighed significantly less. Furthermore, although all subjects maintained stable weights during the study, all groups gained rather than lost a small amount of weight. These data were inconsistent with the fact that, based on objective estimates of energy expenditure and self-reported intake, heavier subjects were in negative energy balance and should have lost weight prior to measurement of RMR. Biased underreporting by heavier subjects may explain this paradoxical finding.

Other behavioral correlates of restraint and disinhibition examined in the study included the number of days when intake was below 800 calories and above 2,500 calories. Findings indicated that 18% of the subjects consumed less than 800 kcal/24hr at anytime during the two-week recording period. This behavior was very infrequent in all groups, averaging less than one day out of the 14. In contrast, 64% of the subjects reported consuming more than 2,500 kcal/24hr at least once during the study. At least 50% of the subjects in each group reported this level of intake. Frequency of intake above 2,500 kcal/24hr ranged from four days for women who were unable to control their eating to two days for the remaining groups. This finding suggests that intake at this level was not considerable in any group.

While the groups did not differ significantly in reported number of meals, snacks, or undereating episodes, women who were unable to control their eating to a satisfactory degree rated significantly more eating episodes as overeating than did women who were in control of their eating (19 vs 7 episodes during the 14-day period). This result is interesting in the light of the fact that the groups did not differ in overall intake. While paradoxical, current findings are consistent with reports of a cognitive bias in individuals with a history of overeating to progressively distort their perception of overeating at higher caloric levels (Williamson, Gleaves, & Lawson, in press). Overall results suggested that women who were unable to control their eating perceived that they overate more often than other groups did, but only occasionally. Significant undereating or overeating was fairly infrequent for all groups. Results also suggested that perception of overeating does not necessarily imply excessive consumption.

Dietary composition differed across the groups. Women who were unable to control their eating consumed a significantly larger proportion of protein in their diets than did women who were able to control their eating (18% vs 15%). The diets of women who controlled their eating consisted of a larger portion of carbohydrates (51% vs 46%), and a lower portion of fat (33% vs 37%), than did the diets of women who did not control their eating. Women who consistently controlled their eating without overeating derived more of their calories from carbohydrates (56%) than did any other group. This finding is consistent with previous reports of higher percentages of carbohydrates in the diets of restrained eaters (Laessle et al., 1989b; Tuschl et al., 1990). All groups consumed above the RDA of 30% fat in the diet (National Research Council, 1989). Dietary fat was higher for women who were unable to control their eating (38%) than for women who did not attempt to control their eating (36%) and for women who alternated between periods of control and loss of control (34%). Dietary fat was lowest in women who consistently controlled their eating (31%). These findings are consistent with new evidence that consumption of high fat food is linked to high body fat (Miller, Lindeman, Wallace, & Niederpruem, 1990). While both obese groups reported high fat intake, interestingly, normal-weight women who did not attempt to control their eating consumed a higher percentage of fat in their diets than did women with a similar percent body fat who maintained consistent control of their eating. The significance of this finding is unclear but may be related to the younger age of normal-weight subjects.

The study also examined frequency of dieting and weight cycling. Women who were unable to control their eating reported more diets within the past year (4 vs 1) and more weight cycles of greater than ten pounds (8 vs 1) than did women who did not overeat. Subjects who controlled their eating reported more frequent diets within the past year than did women who did not control their eating (4 vs 1). While these findings argued for the validity of the constructs of restraint and disinhibition, the similarity in number of diets within the past year among women who were unable to control their eating and those who maintained control suggested that women who are unable to gain control of their eating may occasionally unsuccessfully attempt to do so. However, these attempts are infrequent. In a corresponding manner, women who control their eating may often be unsuccessful at the endeavor. Findings further suggested that restraint and disinhibition may not be completely independent constructs in overweight individuals.

Energy Expenditure

The study examined objective and subjective estimates of subject's energy expenditure. Results from the Caltrac activity meter indicated that subjects who lost control over their eating expended significantly more calories than did subjects who did not lose control (2244 vs 1636 kcal/24hr, respectively). These values represented 548 kcal/day and 342 kcal/day increases over RMR for subjects who did and did not overeat, respectively, suggesting that all subjects generally engaged in sedentary activity (McArdle et al., 1981). Similarly, when subjective estimates of energy expenditure were examined, heavier HD subjects expended significantly more calories than did their lighter LD counterparts. However, all groups of subjects tended to substantially overreport their activity (31-50%) compared to data obtained from the Caltrac.

Results of energy expenditure must be interpreted with caution. Because body weight and RMR were used to calculate both subjective and objective estimates of expenditure, obese subjects' larger body sizes resulted in higher levels of expenditure. When subject's larger body size was taken into account, results using the Caltrac were reversed and indicated that obese women who were unable to control their eating expended significantly fewer calories than did women who were able to control their eating, suggesting that the obese may be less active than normal-weight individuals. When weight was considered for subjective estimates of expenditure, women who controlled their eating reported higher expenditures than did women who did not control their eating. Results suggested that women who control their eating may be more active than women who do not. However, when body weight and composition were statistically controlled, there were no group differences in energy expenditure with the objective measure of activity.

Several methodological considerations also merit attention in interpreting results relating to energy expenditure. First, the perennial problem of self-report data, which was discussed in the previous section, is applicable to the subjective estimates of energy expenditure obtained from the activity record. Subjects may have differentially over- or underreported their activity.

Second, a computational problem in the activity record may have biased results. The finding that subjective estimates of expenditure consistently exceeded those provided by objective estimates (by 31% to 50%) is most likely a function of the rating scale of the activity record. Activity level 2 on the scale was defined as very light activity. Examples of this type of activity were sitting or standing as in laboratory work, typing, and office work. Subjects were instructed that housewives with mechanical aides, teachers, and most professional women engaged in this level of activity. However, the range of activities in these occupations can vary widely from very sedentary to substantially more active. In the study, caloric expenditure from Type 2 activity was calculated as twice that required for Type 1 activity. Type 1 activity was defined as watching television or reading quietly. These values were based on current practices used in the field of exercise physiology (American College of Sports Medicine, 1991; Katch & McArdle, 1983; McArdle, Katch, & Katch, 1981). However, current results suggest that Type 2 activity most likely results in expenditure that is one and a half times as great as that required for Type 1 activity. Subjects reported Type 2 (very light) activity levels during the majority of their waking hours. Because of the bias in the rating scale toward greater energy expenditure for level 2 activity, subjects' estimates of their expenditure were most likely inflated. It is quite possible that they were more sedentary than was represented by their expenditure estimates. Modification of the activity record rating scale will be necessary to remediate the problem.

Finally, although the Caltrac was considered the more valid and reliable estimate of energy expenditure, the device is not without limitations. While the instrument is reliable, it has been shown to overestimate energy expenditure in treadmill walking by an average of 9-13% (Pambianco et al., 1990). The Caltrac also tends to underestimate energy expenditure from movement that it not in the vertical axis (Hunter et al., 1989). However, these limitations were considered minimal in comparison to the problems with subjective estimates of energy expenditure. Therefore, conclusions about energy expenditure were derived from data obtained from the Caltrac.

While overall results with objective estimates of energy expenditure indicated that HD obese subjects expended more energy because of their larger sizes, they tended to be less active than LD lighter subjects. However, when differences in weight were controlled, group differences in energy expenditure were eliminated.

Energy Balance

Data indicated that subjects were in energy balance prior to measurement of resting metabolic rate. Women who were unable to control their eating were in negative energy balance, while women who controlled their eating were in positive energy balance. The discrepancy for the two groups was around 200 kcal per day. This caloric difference is small and would result in insignificant weight loss or gain over a two-week period. This finding was consistent with the observed weight stability of subjects prior to metabolic testing. Subjects' weights fluctuated less than two pounds during the study. However, the finding that subjects were stable in weight during the two-week period of the study cannot be generalized to their long-term eating practices. While subjects were instructed and encouraged not to change their eating or activity patterns during the study, it was not possible to substantiate this. Longitudinal studies are necessary to accurately discern the characteristic eating and activity practices of restrained and disinhibited subjects over longer periods of time.

Summary and Conclusions

The major finding of the present study was that, when body composition was controlled, there were no differences in RMR, energy intake, or energy expenditure, in a heterogenous group of normal women who differed in degree of control and lack of control over their eating. The finding of no differences in RMR was consistent with previous comparisons of normal-weight and obese subjects after controlling for differences in body composition (Foster et al., 1988; Miller & Parsonage, 1975; Prentice et al., 1986; Ravussin et al., 1982; Ravussin et al., 1986; Segal & Gutin, 1983). Results, however, were inconsistent with previous reports of lower RMR in subjects who attempted to control their eating (Devlin et al., 1989; Tuschl et al., 1990). Current findings were also consistent with reports that obese individuals do not eat more than their lean counterparts (Lissner et al., 1989; Mertz et al., 1991; Prentice et al., 1986). While previous evidence of physical inactivity among the obese and its relationship to energy expenditure is difficult to interpret (Shah & Jeffery, 1991), current findings suggest that, while the obese may be less active, they expend similar amounts of energy as do their lean counterparts when body size is controlled.

The study's failure to find group differences in RMR and in behavioral correlates of restraint was most likely associated with the robust relationship between loss of control over eating (disinhibition) and weight. It is possible that disinhibition is a mediating variable in restraint's effect on RMR. In the present study, there was no relationship between restraint and weight. High disinhibition subjects were obese. Low disinhibition subjects were of normal weight. High disinhibition subjects also had significantly larger fat masses and lean body masses than low disinhibition subjects had. In a previous study examining the relationship between restraint and biological variables (Laessle et al., 1989b), restrained subjects had significantly higher disinhibition scores than unrestrained subjects did. However, the subjects in these studies were of normal weight and their mean disinhibition score (7.7) was more similar to those of low disinhibition than of high disinhibition subjects in present study. These findings further suggest that the relationship between restraint and disinhibition may differ in normal-weight and obese subjects.

While biological and behavioral differences in restraint may be demonstrable in normal-weight individuals, the inherent confound of disinhibition and weight makes examination of the independent effects of restraint and disinhibition in overweight subjects quite difficult. In the present study, disinhibition was the overriding variable. Therefore, the absence of restraint effects may be related to the robustness of the effect of disinhibition, and thus weight, in obese subjects. Current findings were consistent with the speculation that weight and restraint are inseparably confounded in the RS (Heatherton et al., 1988; Ruderman, 1986). While it may be possible to measure the two factors independently, by using the TFEQ, it may be quite difficult or impossible to separate them behaviorally in overweight subjects.

Restraint theory predicts that dieting, i.e., control over eating leads to overeating, i.e., loss of control

(Polivy & Herman, 1985). The phenomenon of counter-regulation has been reliably reproduced in the laboratory in some restrained subjects (Polivy & Herman, 1987) but not in others (Duchmann et al., 1989; Herman et al., 1987; Lowe & Kliefield, 1988; Wardle & Beales, 1987, 1988). This discrepancy suggests a great deal of heterogeneity among restrained eaters. Weight status may explain some of this variability. If all individuals who control their eating are likely to lose control of it, then, perhaps, the greater the extent of loss of control and subsequent overeating, the more weight will be gained. Thus weight would increase as disinhibition of eating increased. The causal relationship between these two variables may obsure the relatively minor effects due to dietary restraint. This speculation may explain why, among women who did not lose control of their eating to a significant extent, women who controlled their eating weighed more than women who did not. Women who consistently control their eating may be biologically prone to develop obesity but manage to maintain a relatively normal weight by restricting caloric intake most of the time.

The present study found no differences in RMR, caloric intake, or energy expenditure among women who varied greatly in body size and composition. While women who were unable to control their eating consumed a similar total of calories per day as did women who were able to control their eating, women who lost control were significantly heavier. How then can we account for the differences in weight in these women? If methodological problems, such as underreporting of intake by obese subjects and overreporting of activity, can be ruled out, then we must conclude that there is a metabolic abnormality in obese and potentially-obese individuals which accounts for their propensity for weight gain.

Present results suggest that this deficit is not in resting metabolic rate. While examination of the thermic effect of food (TEF) was beyond the scope of this project, it is quite likely that women who are unable to control their eating, and are overweight, have a defective thermogenic response to food which constitutes a predisposition to obesity. Evidence of a blunted TEF is well-documented in obese subjects (Bessard, Schutz, & Jequier, 1983; Kaplan & Leveille, 1976; Segal, Edano, Blando, & Pi-Sunyer, 1990; Segal, Edano, & Tomas, 1990; Segal, Gutin, Albu, & Pi-Sunyer, 1987; Shah et al., 1988; Shetty, Jung, Barrand, & Callingham, 1981). Obese subjects expend less energy to metabolize ingested food. Therefore, more calories are absorbed and weight is gained. This aberration could account for a significant amount of weight gain over time. The metabolic result of weight cycling may also involve the thremic response to eating rather than resting metabolic rate. Longitudinal studies are necessary to determine the specific long-term effects of weight cycling on metabolic processes.

While other researchers have found biological and behavioral differences between high and low restraint subjects, these findings have been reported only in normal-weight individuals. The present study's attempt to extend the findings to individuals of varying weights revealed several confounding factors. Although there may be a subgroup of normal-weight women who have lower RMRs, as weight increases, it becomes the predominant factor influencing biological, behavioral, and psychological processes.

While, most researchers have assumed that all, or most, obese individuals were restrained eaters, present findings strongly refute this assumption. This study identified two distinct groups of obese women. The first group did not attempt to control their eating. These women weighed significantly more, and had substantially larger fat and fat-free body masses, than did the other group of obese women. The other group of women, who cycled between control and loss of control of their eating, weighed significantly less, and had significantly less fat and lean body mass, than obese subjects who did not control their eating. Restraint appeared to attenuate body size in the group of women who alternated between control of their eating and overeating. While the difference was not significant, women who alternated between control and loss of control consumed almost 500 kcal/24hr less than the group who did not attempt to control their eating. Therefore, the effects of restraint may be important in one subgroup of obese women but not in the subgroup of obese women who are unable to control their eating.

Because these two groups were overweight, both types of women are likely to be included in obese samples for obesity research. However, the present study demonstrated that there are substantial differences between the two obese groups. Similarly, the differences demonstrated between normal-weight women who control their eating and those who do not suggest that these factors are also important in describing control subjects in obesity research. Because control and lack of control over eating can have significant effects on biological processes, failure to distinguish between subgroups of obese subjects or normal-weight control subjects could render interpretation of data from obesity studies confusing and may lead to erroneous conclusions.

While dieting may be an antecedent to overeating in vulnerable individuals, many women are able to refrain from loss of control over eating. Current results suggest that intent to diet does not imply success. The caloric intake of women who controlled their eating was similar to that of women who did not attempt to control their eating.

Disinhibition may be a very powerful mediating factor in biological processes. Current results indicate that in a group of normal women of varying ages and weights, weight status, as confounded with disinhibition, and not restraint, was the predominant variable affecting RMR. The overriding influence of disinhibition in the present study prevents the comparison of results with previous findings on restraint. To elucidate the independent biological and behavioral effects of disinhibition and restraint, future research should examine differences between these variables in individuals at more restricted weight levels. While restraint may have prognostic significance in normal-weight women, disinhibition may be a much more important factor in obese subjects. Current findings indicate that restrained eaters are indeed a heterogenous group. Conclusions are congruous with Tuschl's (1990) speculation that the construct of restrained eating is significantly more complex than originally thought.

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145-149, Appendix A

150-155, Appendix B

156-158, Appendix C

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Appendix D

EATING QUESTIONNAIRE - REVISED

Name:____________________ Date:_______________

Directions: In the space provided, indicate the letter of the answer that best describes your eating behavior.

_______ 1. How often do you binge eat? (a) seldom; (b) once or twice a month; (c) once a week; (d) almost every day; (e) every day.

_______ 2. What is the average length of a binging episode? (a) less than 15 minutes; (b) 15-30 minutes; (c) 30 minutes to 1 hour (d) 1 hour to 2 hours; (e) more than 2 hours (if e, please indicate length of episode __________).

_______ 3. Which of the following statements best applies to your binge eating? (a) I don't eat enough to satisfy me; (b) I eat until I've had enough to satisfy me; (c) I eat until my stomach feels full; (d) I eat until my stomach is painfully full; (e) I eat until I can't eat anymore.

_______ 4. Do you ever vomit after a binge? (a) never; (b) about 25% of the time; (c) about 50% of the time; (d) about 75% of the time; (e) about 100% of the time.

_______ 5. Which of the following best applies to your eating behavior when binge eating? (a) I eat much more slowly than usual; (b) I eat somewhat more slowly than usual; (c) I eat at about the same speed as I usually do; (d) I eat somewhat faster than usual; (e) I eat very rapidly.

_______ 6. How much are you concerned about your binge eating? (a) not bothered at all; (b) bothers me a little; (c) moderately concerned; (d) a major concern; (e) the most important concern in my life.

_______ 7. Which best describes the control you feel over your eating during a binge? (a) never in control; (b) in control about 25% of the time; (c) in control about 50% of the time; (d) in control about 75% of the time; (e) always in control.

_______ 8. Which of the following describes your feelings immediately after a binge? (a) I feel very good; (b) I feel good; (c) I feel fairly neutral, not too nervous or uncomfortable; (d) I am moderately nervous and/or uncomfortable; (e) I am very nervous and/or uncomfortable.

_______ 9. Which most accurately describes your mood immediately after a binge? (a) very happy; (b) moderately happy; (c) neutral; (d) moderately depressed; (e) very depressed.

_______ 10. Which of the following best describes the situation in which you typically binge? (a) always completely alone; (b) alone but around unknown others (e.g., restaurant); (c) only around others who know about my binging; (d) only around friends and family; (e) in any situation.

_______ 11. Which of the following best describes any weight changes you have experienced in the last year? (a) 0-5 lbs; (b) 5-10 lbs; (c) 10-20 lbs; (d) 20-30 lbs; (e) more than 30 lbs.

_______ 12. On a day that you binge, how many binge episodes typically occur during that day? (a) 0; (b) 1; (c) 2; (d) 3; (e) 4 or more.

_______ 13. How often do you use restrictive diets/fasts? (a) never; (b) one time per month; (c) two times per month; (d) one time per week; (e) almost always.

_______ 14. How often do you use laxatives to lose weight? (a) never; (b) 1-3 times per month; (c) one time per week; (d) one time per day; (e) more than one time per day (if e, please indicate frequency ________).

________ 15. How often do you use diuretics to lose weight? (a) never; (b) 1-3 times per month; (c) one time per week; (d) one time per dayl (e) more than one time per day (if e, please indicate frequency ________).

Appendix F

Personal History Questionnaire

Name: ______________________________ Age: ________

PLEASE CIRCLE THE CORRECT RESPONSE.

1. Have you ever been diagnosed with:
   a) respiratory disease (bronchitis, asthma, COPD) Yes No
   b) thyroid disease Yes No
   c) heart disease Yes No
   d) kidney disease Yes No
   e) high blood pressure Yes No
   f) diabetes Yes No
   g) depression Yes No
   h) other ______________________________

2. Are you currently taking any medication? Yes No

   If yes, please list the medications below: (Please include birth control pills, prescription, and over-the-counter medication)?

   ____

   ____

3. Are you currently having a menstrual cycle? Yes No

4. Are your menstrual cycles regular? Yes No

5. When did your last menstrual period begin? ______________

6. Are you pregnant? Yes No

7. Do you smoke cigarettes? Yes No
   If yes, how many packs per day do you smoke? ______

8. Do you drink coffee, tea, or soft drinks? Yes No
   How many cups of coffee per day? ______________
   How many cups/glasses of tea per day? ______________
   How many soft drinks per day? ______________

9. Are any of the beverages listed above decaffienated?
   a) coffee Yes No
   a) tea Yes No
   a) soft drinks Yes No

10. Do you engage in regular physical activity? Yes No
    If yes, how many hours per week? ______________

11. Have you ever been on a diet? Yes No

12. At what age did you begin to diet? ______________

13. In your first year of dieting, how many times did you start a diet? ______ times

14. How many times did you start a diet within the past year? ______ times

15. Are you currently dieting? Yes No

16. What is your current weight and height?

    Current Weight: _________ pounds

    Current Height: _____ feet ______ inches

17. What is your desired weight? ___________ pounds

18. What was your highest weight? ________ lbs at age ______

19. What was your lowest adult weight? _____ lbs at age ____

20. Have you ever been overweight? Yes No
    If yes, were you overweight in:
    a) infancy (0-2 years) Yes No
    b) childhood (2-12 years) Yes No
    c) adolescence (13-20 years) Yes No
    d) adulthood (over 20 years) Yes No

21. Has your weight fluctuated up and down during most of your adult life? Yes No
    If yes, how many times have you gained or lost more than ten pounds? ______ times

22. Compared to five years ago, have you:
    a) gained 5 or less pounds
    b) gained 10 pounds
    c) gained 15 pounds
    d) gained 20 or more pounds
    e) lost 5 pounds
    f) lost 10 pounds
    g) lost 15 pounds
    h) lost 20 or more pounds

23. Have you lost any weight in the past few months? Yes No
    _____ pounds

24. Have you gained any weight in the past few months? Yes No
    _____ pounds

25. Is there anyone in your immediate family who is or was overweight?

a) your mother	Yes	No
b) your father	Yes	No
c) your sister(s)	Yes	No
d) your brother(s)	Yes	No
e) your children	Yes	No

Interview for Diagnosis of Eating Disorders (IDED)

DATE ____________
NAME ______________________________ AGE _____ RACE _____
DATE OF BIRTH ____________ WEIGHT ______ HEIGHT _______
ADDRESS ____
TELEPHONE ______________ REFERRED BY ____________________

I. *General Assessment and History*

1. What types of problems do you have with eating or weight-related matters? How long has this been a problem?

2. What has been your highest and lowest weight? When?

3. Were you overweight as a child? Y N (Describe.)

4. Were you/are you overweight as an adolescent? Y N (Describe.)

5. What has been the course of your eating problems? (How the behavior began, increases, decreases, changes in eating.)

6. Have you had any medical/dental problems? (Check for dizziness, LBP, HBP, tooth erosion, thyroid problems, diabetes.)

7. Do you avoid eating certain foods? Y N (Describe.)

   What emotional reaction occurs when you eat these "forbidden" foods? (Foods which are avoided or purged due to a belief that the foods will lead to rapid and significant weight gain.)

8. How many members are there in your household?

   Do they know about your eating problems? Y N
   If yes, how do they react/feel about your eating disorder?

Would they participate in your treatment?

II. *Anorexia Nervosa*

1. Do you currently go periods of time without eating (starvation) to control your weight? Y N (If Y, describe.)

   When did you first begin to lose weight/restrict your eating?

   Are there any factors/situations which seem to increase or decrease periods of restrictive eating?

2. Do you feel that your weight is normal? Y N (Describe.)

3. What emotional reaction would you have if you lost
   2 lbs.?

   5 lbs.?

   10 lbs.?

   What emotional reaction would you have if you gained
   2 lbs.?

   5 lbs.?

   10 lbs.?

4. Do you wish to be thinner than you are now? Y N
(If Y, ask what body areas should be thinner.)

What is your goal weight?

Do you think or worry a lot about your weight and body size?

Do you often feel "fat" when you gain only a few pounds? Y N
(Describe.)

Do you weigh yourself often? Y N How often?

5. When was your last menstrual cycle?

Have you experienced menstrual irregularities within the last three months? Y N (Describe.)

III. *Bulimia Nervosa*

1. Do you ever binge (rapid consumption of large amounts of food in a discrete period of time)? What is the daily course of your binge eating? (Describe all covert and overt events that usually occur prior to, during, and after a binge.)

Do you ever feel as though you have overeaten when you eat small portions of certain fattening foods? Y N (Describe.)

When did you first begin to have problems with binging?

Are there any factors which appear to increase or decrease the frequency of binge eating?

2. Do you feel out of control prior to or during a binge? Y N (Describe.) Do you feel hungry prior to a binge? Y N

3. Do you purge after meals or after a binge? Y N

   Do you vomit? Y N How often per day/week?

   Do you use laxatives? Y N How often, what type?

   Do you use diuretics? Y N How often, what type?

   Do you use appetite suppressants? Y N How often, what type?

   Do you often go on strict diets? Y N How often, what type?

   Do you engage in vigorous exercise? Y N How often, what type?

   When did you first begin to purge?

   Are there any factors which appear to increase or decrease the frequency of purging?

4. How often does the binge eating occur?

How long have you been binging at least twice per week?

How often does the binge-purge cycle occur?

IV. *Compulsive Overeating*

1. If you binge, what types of food do you typically eat?

2. Do you binge alone, or in secret? Y N (Describe.)

3. What emotions typically precede a binge?

4. Do you often attempt to diet in order to lose weight? (Describe.)

5. Have you had frequent weight fluctuations greater than 10 pounds in the past few years? Y N (Describe.)

Interview for Diagnosis of Eating Disorders (IDED)

6. Do you consider your eating to be abnormal? Y N
   Do you feel that you have control over your eating? Y N

7. How do you feel during and after a binge episode? (Describe.)

8. Are you satisfied with your current weight? Y N

   If no, what is your weight goal?

Rating Scale for the IDED

I. *Anorexia Nervosa*

1. Refusal to maintain appropriate weight for height

1	2	3	4	5	6	7
Accepts normal weight	Prefers 5% below normal weight	Prefers 10% below normal weight	Prefers 15% below normal weight	Prefers 20% below normal weight	Prefers 25% below normal weight	Prefers greater than 25% below normal weight

2. Intense fear of weight gain

1	2	3	4	5	6	7
No Problem	Minimal Problem	Minimal Fear	Moder-ate Fear	Strong Fear	Intense Fear	Morbid Fear

3. Body image disturbance: Feels "fat" even though not significantly overweight

1	2	3	4	5	6	7
Never	Occa-sion-ally when "stuffed"	After eating meals	After eating small amounts of food	Most of the time	Almost all of time	All of the time

Rating Scale for the IDED

4. Amenorrhea

1	2	3	4	5	6	7
Very Regular	Slight Irregu-larity	Missed 2 cycles last 6 months	Missed 3 cycles last 6 months	Missed 4 cycles last 6 months	Missed 5 cycles last 6 months	Missed 6 cycles last 6 months

II. *Bulimia Nervosa*

1. Recurrent binge-eating episodes

1	2	3	4	5	6	7
Never binges	Infre-quent and small	Infre-quent but large	Frequent and large	Frequent includ-ing binges and for-bidden foods	Very fre-quent w/ only large binges	Very fre-quent w/ binges plus for-bidden foods

2. Feeling of loss of control during binge eating

1	2	3	4	5	6	7
Always in control	Rare loss of control	Occa-sional loss of control	Frequent loss of control	Usually out of control	Almost always out of control	Never in control

3. Purgative behavior

1	2	3	4	5	6	7
None	Purges 1–2 times/ year	Purges 1 time/3 months	Purges 1–3 times/ month	Purges 1–2 times/ week	Purges 3–6 times/ week	Purges 1 or more times/ day

4. Frequency of binge eating

1	2	3	4	5	6	7
Rarely occurs	Occurs a few times/ year	1–4 times/ month	5–8 times/ month	2–3 times/ week	4–6 times/ week	Occurs daily or almost daily

5. Overconcern with body shape and size

1	2	3	4	5	6	7
No over-concern	Minimal concern	Some preoc-cupation	Mode-rate degree of preoc-cupation	Preoc-cupied most of the time	Preoc-cupied almost all of the time	Preoc-cupied all of the time

III. *Compulsive Overeating*

1. Frequency of recurrent binge-eating episodes

1	2	3	4	5	6	7
Never Binges	Binges less than once per month	Binges once per week or less	Binges about twice per week	Binges 3 to 6 times per week	Binges once per day	Usually binges more than once per day

2. Consumption of high-calorie, easily ingested food during a binge

1	2	3	4	5	6	7
No binges	Minimal Overeat of nor-mal foods	Moder-ate Overeat of nor-mal foods	Binges on nor-mal foods	Binges on nor-mal and hi-cal foods	Binges exclu-sively on hi-cal foods	Overeats at meals and binges only on hi-cal foods

Rating Scale for the IDED

3. Inconspicuous eating during a binge

1	2	3	4	5	6	7
No binges	Prefers to eat with friends or family	Overeats with friends or family	Binges with few people	Binges at home alone with others in house	Rarely binges with anyone else present	Binges only when alone

4. Repeated efforts at dieting

1	2	3	4	5	6	7
Never diets	Diets 1–2 times/ year	Diets 3–4 times/ year	Diets 5–6 times/ year	Diets every month	Diets almost every week	Diets all of the time

5. Negative affect prior to binge

1	2	3	4	5	6	7
No binges	Seldom overeats due to negative affect	Sometimes overeats due to negative affect	Often binges due to negative affect	Usually binges due to negative affect	Almost always binges due to negative affect	Always binges due to negative affect

6. Frequent weight fluctuations greater than 10 lbs.

1	2	3	4	5	6	7
None	Minimal weight fluctuation	Few 1–9 lbs.	Few 10 lbs.	Many 10 lbs.	Few 10–20 lbs.	Many 10–20 lbs.

7. Absence of purgative behaviors

1	2	3	4	5	6	7
Purges daily	Purges weekly	Purges monthly	Purges Infrequently	Purges 1–2 times/year	Diets occasionally	None

8. Realization that eating pattern is abnormal/out of control

1	2	3	4	5	6	7
No problem	Minimal problem	Occasional mild feelings	Frequent mild feelings	Frequent moderate feelings	Frequent intense feelings	Extremely frequent and intense

9. Depressed mood and self-deprecating thoughts after a binge

1	2	3	4	5	6	7
No binges	No depression post-binge	Minimal depression post-binge	Modest depression post-binge	Moderate depression post-binge	Severe depression post-binge	Extreme depression post-binge

10. Body size dissatisfaction

1	2	3	4	5	6	7
Never	Occasional when "stuffed"	After eating meals	After eating small amounts of food	Most of the time	Almost all of the time	All of the time

Appendix H

Food Record

Pennington Biomedical Research Center

FOOD RECORD

SUBJECT ID ____________________ SUBJECT TEL. NO. __________

DATE STARTED: __________ COMPLETED: __________

DATE OF INTERVIEW ______________________________

INTERVIEWER I.D. ______________________________

INSTRUCTION SUMMARY

1. <u>KEY</u> FOR ABBREVIATIONS:
   a. *Location:* where was the food consumed, Wendy's, McDonald's, home, etc.
   b. *With:* friend, family, alone, other
   c. *Overeat* (this your perception):

5 = overeat	3 = did not overeat	1 = underate
4 = slightly overate	2 = slightly underate	0 = binged

   d. *Mood Prior:* very negative, negative, neutral, positive, very positive
   e. *Event Prior:* exercise, television, social, work, relaxation, other
   f. *Meal:*: B = breakfast L = lunch
      D = dinner S = snack
   g. *Hunger Prior:* 4 = very hungry
      3 = moderately hungry
      2 = neutral
      1 = not hungry
      0 = full

2. Columns:
   (1) Record the exact time that food, beverage, medication or supplement was consumed.

   (2) Record everything you eat or drink – food, beverages (excluding water), prescription medications, and non-prescription medications such as aspirin, diuretics, laxatives and vitamin/mineral supplements. Keep the diary with you and record items *<u>as consumed</u>*.

   (3) Record the amount you consumed. *EVERY ITEM MUST HAVE AN AMOUNT.* Give the amount in ounces, grams, teaspoons, tablespoons, cups, etc. The portable measurement kit will aid in measurement.

   (4) Record how the food or beverage was prepared (i.e. fried, baked, raw, blended, etc.), If you are eating outside the home, don't be afraid to ask questions.

   (5) Record the brand and type of the item (i.e. *Borden skim* milk, *Dannon lowfat* yogurt) as frequently as possible.

3. Record one meal or snack per page. Always start a new meal or snack on a clean page. If more than one page is needed for a meal or snack, use the next page and *Date each page.*

4. Recording everything you eat or drink may influence your eating somewhat. For this study to truly represent your habits, try to minimize this effect and carry on your usual eating habits.

SAMPLE

Date: Nov. 11 Day of week: Saturday

a. Loc: Home
b. With: (fr fa al ot)
c. Overeat: 5 4 3 2 1 0
d. Mood: (= - n + ++)
e. Event Prior: (ex tv soc w rel ot)
f. Meal: (B L D S)
g. Hunger: (4 3 2 1 0)

(1) Time	(2) Food/Beverage/Supplement/ Medication	(3) Amount	(4) Preparation	(5) Brand and/ or Type
10 a.m.	Lasagna	8 oz.	Baked	Wt. Watcher
	Green Beans	1/2 c.	Boiled	fresh
	Pudding	1/2 c	package directions	Jello Sugar Free Vanilla
	Milk	8 oz.		Borden 2% lowfat

Appendix I

Activity Record

TABLE 2: LEVELS OF ACTIVITY

Score	Type	Examples
0	Sleeping:	
1	Reclining:	Watching television, reading quietly.
2	Very Light:	Seated or standing activities such as painters, cab and truck drivers, laboratory workers, typists, musicians, stitchers, office workers.
	Men:	Office workers, most professional occupations.
	Women:	Office workers, housewives with mechanical aides such as dishwashers, etc., teachers and most other professional women.
3	Light:	Walking on level at 2.53 mph, tailors, pressers, garage work, electricians, carpentry, restaurant trades, cannery workers, manual clothes washing, shopping with light load, golf, sailing, table tennis, volleyball.
	Men:	Most men in light industry, students, building workers except for heavy laborers, many farmers.
	Women:	Light industry, housewives with mechanical appliances, department store workers, students.
4	Moderate:	Walking 3.5-4 mph, plasterers, weeding and hoeing, scrubbing floors, stockroom with loading and stacking heavy loads, shopping with a heavy load, bicycling, skiing, tennis and dancing.
	Men:	Some agricultural workers, unskilled laborers, forestry workers (except lumberjacks), soldiers, miners, steelworkers).
	Women:	Some farm workers, dancers, athletes.
5	Heavy:	Walking uphill with a load, lumberjack, pick and shovel work, basketball, swimming, climbing, football.
	Men:	Lumberjacks, blacksmiths, rickshaw-pullers.
	Women:	Construction workers.

ACTIVITY MONITOR CHART

DAY # ___________

HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL
12-1a.m.		8-9 a.m.		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1 p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

ACTIVITY MONITOR CHART

DAY # ___________

HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL
12-1a.m.		8-9 a.m.		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1 p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

ACTIVITY MONITOR CHART

DAY # ___________

HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL	HOUR	ACTIVITY LEVEL
12-1a.m.		8-9 a.m.		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1 p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

CALTRAC ACTIVITY COUNTS

DAY #1:__________

12-1a.m.		8-9		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

NOTE: When sleeping, indicate on daily chart. Record activity counts when you awaken and before arising.

CALTRAC ACTIVITY COUNTS

DAY #1:__________

12-1a.m.		8-9		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

NOTE: When sleeping, indicate on daily chart. Record activity counts when you awaken and before arising.

CALTRAC ACTIVITY COUNTS

DAY #1:__________

12-1a.m.		8-9		4-5 p.m.	
1-2		9-10		5-6	
2-3		10-11		6-7	
3-4		11-12		7-8	
4-5		12-1p.m.		8-9	
5-6		1-2		9-10	
6-7		2-3		10-11	
7-8		3-4		11-12	

NOTE: When sleeping, indicate on daily chart. Record activity counts when you awaken and before arising.

Vita

Olga Lawson was born in New Orleans, Louisiana on January 2, 1947. She graduated from the Academy of the Sacred Heart in New Orleans, Louisiana in June of 1964. In May, 1968, she received a B.S. degree in Medical Technology, with minors in biology and chemistry, from Loyola University in New Orleans. In December, 1987, she receieved a Master of Arts degree in clinical psychology from Louisiana State University. She will receive a Doctor of Philosopy degree in clinical psychology, with a minor in behavioral neurology, from Louisiana State University in May of 1992.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Olga J. Lawson

Major Field: Psychology

Title of Dissertation: Dietary Restraint, Disinhibition of Eating, and Resting Metabolic Rate in Women

Approved:

Donald A. Williamson
Major Professor and Chairman

Kathleen De la Peña McCook
Dean of the Graduate School

EXAMINING COMMITTEE:

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Date of Examination:

December 10, 1991